INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

YGL BULLETIN

NO. 3

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INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

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MAY 1972

UNITED STATES

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DEPARTMENT OF DEFENSE

DEPARTMENT OF INTERIOR

DEPARTMENT OF TRANSPORTATION

ENVIRONMENTAL PROTECTION AGENCY

NATIONAL SCIENCE FOUNDATION

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EDITORIAL NOTE

The field operations phase of the International Field Year for the Great Lakes (IFYGL) will begin on April 1, 1972. The IFYGL Bulletin has been designed as a means of reporting on the planning, progress and results of this joint Canadian-United States scientific effort. It will also serve as a vehicle for information exchange among IFYGL participants, as well as others who have an interest in the program and may wish to use IFYGL data. The first issue of the Bulletin gave a preliminary overview of the status of the organization and planning for the scientific program to be conducted by the United States. IFYGL Bulletin No. 2 provided a similar coverage of Canadian participation. This and subsequent issues will review status and results of both the United States and Canadian programs in relation to the Joint (U.S. - Canadian) Technical Plan and will contain contributions both from the U.S. and Canadian participants. As the field operations get underway, announcements of general interest to the scientific community and to those directly engaged in the program will be made, and when data collected during the field operations become available, from individual scientists and IFYGL archives, their existence will be made known. Still later issues will report on experimental results and analyses of individual experiments and projects, both Canadian and United States.

Contributions on all aspects of the IFYGL program are invited from participants in Canada and the United States, including comments and critiques pertinent to plans and to problems encountered as the program enters its active field phase. Such contributions should be sent to:

IFYGL Centre
Canada Centre for Inland Waters
P.O. Box 5050
Burlington, Ontario

or

National Oceanic and Atmospheric Administration
Code EM&P-IFYGL, Room 805, Building 5
6010 Executive Boulevard
Rockville, Md. 20852

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CANADA

Remarks by Major-General H. A. Young
Chairman, CNC/IHD,
at Opening of International Field Year for the Great Lakes,
Canada Centre for Inland Waters
March 30, 1972

Today is the start of the operational phase of the International Field Year for the Great Lakes and the culmination of close to six years of intensive planning. You have been given details of the program, what is going to be done, and the reasons why. These sound similar in general to many other international and bi-national scientific programs, but, the concept and planning of the IFYGL are different and make it the first truly integrated bi-national scientific program.

Large scientific programs always have had a central theme and a general program plan. However, each participating nation planned and conducted its piece of the general program almost entirely independently. Each nation also presented its findings independently and the results were seldom drawn together to provide a single comprehensive picture.

The IFYGL, in contrast, was planned from the start as a single program involving many people in a broad spectrum of scientific fields all directing their efforts towards improving our knowledge of the processes taking place in the Lake Ontario Basin and making this knowledge available in a form that could be used by our two countries to keep the Great Lakes a useable and enjoyable resource.

More than 150 Canadian and U.S. scientists and engineers were involved in planning the program and many more will be involved in carrying it out and analyzing the results. These people and the facilities supporting them are provided by Canadian and U.S. government agencies and universities who have recognized the value of concentrating integrated studies at one time so that the results can be used by all. These people will be undertaking hundreds of tasks and gathering millions of bits of data. It has been estimated that all the bits of data collected during the Field Year could be concisely summarized on 40,000 sheets of $8\frac{1}{2}$" x 11" paper. This study is being done within a single program defined by the drainage basin of Lake Ontario, not by political or disciplinary boundaries.

The IFYGL will be producing many models of lake processes and, equally important, it will be a model for future large integrated scientific programs.

CANADIAN INSTRUMENTATION AND OBSERVING SYSTEMS

Introduction

In IFYGL Bulletin 2 a brief account was given of the nature of the Canadian Scientific program, and where and when the various activities would take place. A major emphasis in this issue is to provide an account of how some of our observations are made and how all IFYGL field parties establish their position within the basin by a common network.

The information on CCIW systems was largely provided by the Engineering and Scientific Support Division of CCIW, under the direction of Mr. A. S. Atkinson. The description of the IFYGL basin-wide position fixing system was compiled from information provided by Computing Devices of Canada and by Marine Science Branch at CCIW under the direction of Mr. T. McCulloch. The account of the Atmospheric Environment Service systems was provided by Mr. J. A. W. McCulloch.

Canada Centre for Inland Waters Observing Systems

Current Meter Buoys

During IFYGL, CCIW will maintain in Lake Ontario at least 15 moored current-measuring stations, 7 of which are one-current-meter stations, and 8 are four-current-meter stations. The physical configuration of these moored measuring systems is shown in Figure 1, a design which has evolved at CCIW over a number of seasons.

To maintain 15 stations a stockpile of 85 current meters exists, including about an equal number of Geodyne Type 920-3 and Plessey Type MO21 meters. Either can be used interchangeably in the moored system as required. Each meter is an independent, magnetic tape recording, self-powered and timed device for measuring current speed, current direction, and water temperature. The number of meters at each station is given in Table 1.

The Geodyne Type 920-3 model makes an almost instantaneous measurement of current speed, using a savonius rotor, over the range 2 to 360 cm/s, to an accuracy of 2.5 cm/s (to 50 cm/s). Current direction is sensed by a magnetic compass attached to an optical device and is accurate to 6^{o}. The single temperature sensor is 0.1^{o}C accurate from -2 to 35 ^{o}C. The current-meter clock is electronic 1 in 10^5 accuracy, and produces both an elapsed-time data word, and the necessary 10-minute sampling pulses. Digitization of each sensor signal is done to a 12-bit resolution. These digital measurements, or data words, are serially multiplexed on to a single channel incremental cartridge tape recorder, with capacity for 3×10^5 such data words. At a 10-minute sampling rate, instrument ultimate endurance is about 50 days; the scheduled operating period is 35 days.

Table 1. The number of current meters at each IFYGL lake station, as marked on Figure 1 of IFYGL Bulletin 2.

Station	Latitude North			Longitude West			Water Depth (M)	Number of Meters
	Deg.	Min.	Sec.	Deg.	Min.	Sec.		
1								0
2	43	31	00	79	19	00	108	4
3	43	25	00	79	17	00	117	3
4	43	19	00	79	14	00	14	4
4a								0
5								0
6	43	44	00	78	49	00	83	4
7								0
8	43	49	30	78	02	30	63	3
9	43	50	00	77	41	00	68	4
10	43	39	30	77	42	30	138	4
11	43	47	00	76	49	30	74	4
13	43	26	00	78	44	00	129	2
Presqu'ile coastal chain								2
Oshawa coastal chain								5

The Plessey Type M021 current meter provides an integrated (or effective mean) measure of current speed, over the 10-minute sampling interval, using an unducted impeller sensor. This measurement is followed by an instantaneous measurement of direction. Operating range is 5 to 250 cm/s (actually CCIW threshold tests show threshold at 4 cm/s). Accuracy is $\pm$ 3 cm/s. Direction sensing is by compass and potentiometer with accuracy of $\pm 5^{\circ}$. The single temperature sensor is accurate to $\pm$ 0.15 $^{\circ}$C from -5 to 25 $^{\circ}$C. The clock in the instrument is accurate to $\pm$ 0.02%, and provides the 10-minute sampling pulses. The digitization technique in this meter is primarily electromechanical, to 8-bit (1 in 256) resolution. The incremental tape recorder uses 1/4 inch tape, in reel-to-reel configuration, and stores up to 55 000 data-words. With 10-minute sampling, plus the incorporated redundancy in measuring, instrument endurance is 60 days.

The moored-buoy system, designed for the relatively shallow Great Lake environment, features two floats. One is the well-proven Nun buoy float, for marking and location. The actual current-meter array is attached to a taut line running from an anchor to a subsurface float for minimum mooring motion. The surface float and pennant on the taut line system, is very small, and only used for exact location. The current-meter portion of the system is manually retrieved for data recovery, maintenance, etc.

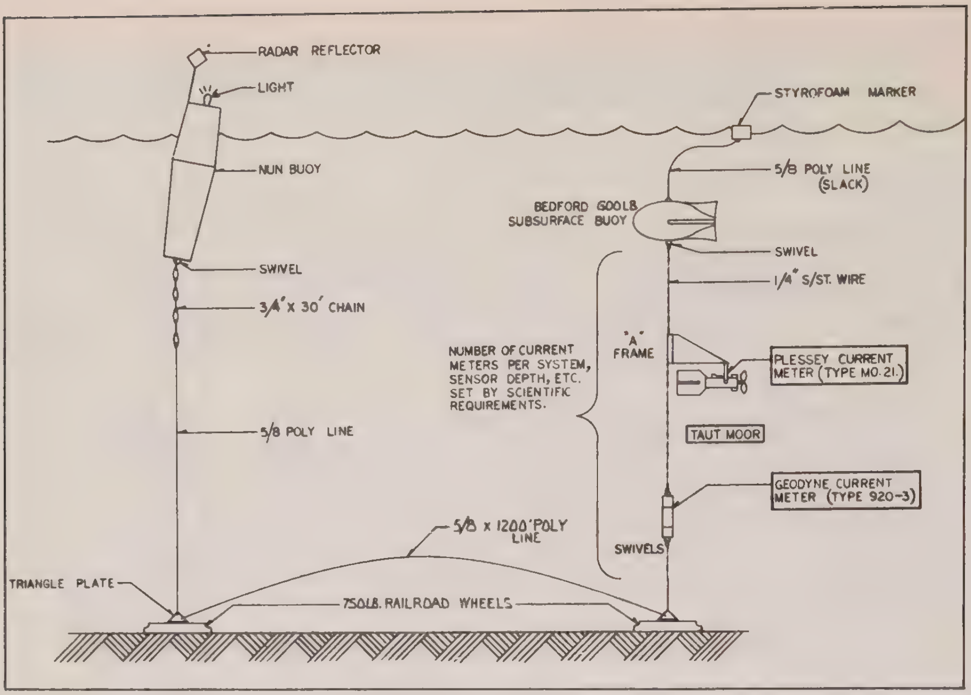

Figure 1. Current meter mooring configuration. The number of meters at each station shown in Figure 1 of IFYGL Bulletin 2 is given in Table 1.

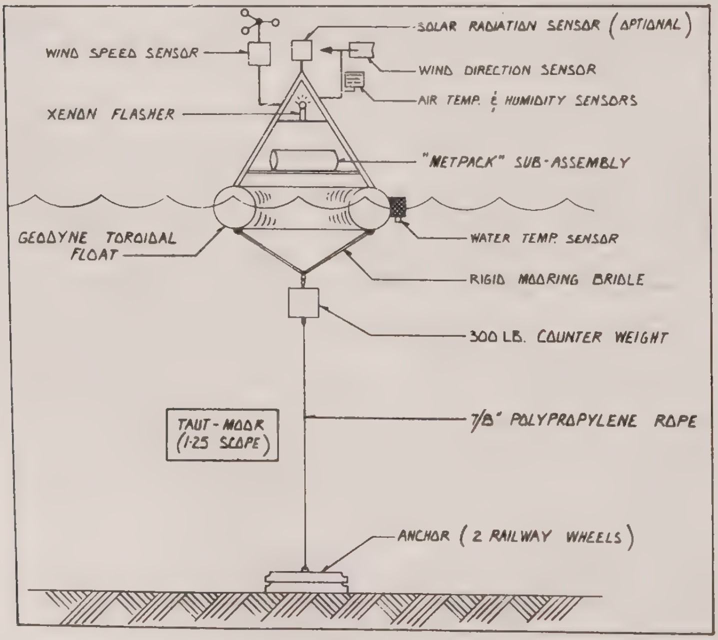

Figure 2. Lake-wide synoptic meteorological observations are made 4 m above the lake surface with this system at the eleven stations marked in Figure 1 of IFYGL Bulletin 2 (numbered 1 to 11).

Data reduction of both production-type test recordings and actual field recordings commences with data translation, whereby the particular serial formats of both the Geodyne data and Plessey data are translated into standard 1/2 inch IBM-compatible tapes. The translation system utilizes playback tape decks interfaced to a PDP-8 mini-computer.

The beginning and end of each field tape is printed out by teletype and evaluated. Any errors and faults are recognized, corrected, and other field history parameters inserted into the final tape record which then becomes part of the IFYGL data bank. Approximately 2.5×10^6 independent current samples will be produced by these CCIW current-measuring systems during IFYGL.

Meteorological Buoys

This system is intended to provide automatic acquisition and recording of meteorological parameters, at the air/water interface, in the Great Lakes. A diagrammatic sketch of the system is given in Figure 2.

The buoy platform is designed around the well-known toroidal surface float made of fibreglass-sheathed polyurethane. The meteorological instruments are mounted on an aluminum tripod structure 4 m above the lake surface, by a technique which permits a quick mechanical and electrical disconnect during in-season monitoring. Due to payload drag and weight distribution, the buoy float has to be counter-weighted to maintain stability. Buoy motions are reduced by using a length of polypropylene line matched to the water depth and forming a taut-line mooring.

The full complement of sensors is shown in Figure 2. Some stations are not fitted with global solar radiation and barometric pressure units. The weather sensors are: 3-cup anemometer; dewcell; and naturally ventilated thermometer; all of which produce a variable resistance output. Each buoy is also equipped with a water temperature sensor. The complete sensor group is scanned once every 10 minutes, producing an almost simultaneous measurement. Each sensor signal is digitized to a 10-bit resolution, and recorded on board in a miniature low-power incremental tape recorder, in serial digital format. This recorder has storage capacity for 55 000 data words, corresponding to an ultimate system endurance of about 50 days, although the scheduled IFYGL recording period is one month. Interwoven with the weather data in the recording sequence are normal status and reference words, together with a timing signal from the electronic clock. Electronics, batteries, and recorder comprise a single data-logging package, accessibly mounted above the buoy waterline as shown in Figure 2.

To achieve IFYGL program targets, a distributed array of 11 such moored measuring stations is needed in the northern portion of Lake Ontario; these 11 stations are to be continuously operating for at least 6 months. To implement this task of data acquisition, taking into account all logistic factors, a rotating stock of 22 instrumentation systems with sensors is required, plus a complex and detailed procedure for field monitoring, data retrieval, and equipment overhaul. System monitoring in situ occurs every two weeks by means of special digital monitoring test units which are plugged

into a working buoy system to confirm reliable overall operation. Data retrieval occurs monthly, by changing the reel of magnetic tape. The first stage in data processing is data translation, whereby the special format is changed into a standard language and then put on a computer-compatible tape. The new tape is flagged for buoy position and history, and thoroughly error checked for both parity and instrumental errors.

Subsequently in-depth scientific analysis of this particular component of the overall IFYGL data bank will be undertaken. Approximately 2×10^6 measurements obtained by these meteorological buoy systems will be lodged in the data bank.

Lake Temperature Profiler Buoys

The CCIW Fixed Temperature Profiler (FTP) is a moored, self-contained 18-channel system capable of acquiring and storing up to 18×10^4 independent water temperature measurements over a period of up to 60 days unattended operation. In support of the IFYGL program, 4 such moored systems will be maintained at separate locations in Lake Ontario over a period of several months. (See Bulletin 2, page 14, Figure 1) The system is shown in Figure 3.

In the overall system there are three major elements or subsystems, namely: the temperature-sensing (thermistor) probes; the cable assembly; and the digitizing, recording package.

The temperature is observed with thermistors which are carefully matched and calibrated to within 0.1°C through the operating range 0 to 25°C. The time constant of the probes is matched to the 10-minute sampling interval of the system, using specially-molded neoprene lagging shields. The second major part of the FTP system is a 100 m long two-part cable assembly which serves three operating functions. The electrical cable member positions the 18 temperature probes at the required depths (linear spacing from 0.2 m to 30 m, and logarithmic spacing below), and couples the thermistor resistances to the inputs of the digitizer. The mechanical member of the cable assembly takes the stresses of the mooring and keeps the electrical cable suitably supported and located. Finally the third element in the measuring system (the digitizer) scans the 19 thermistor inputs at 10-minute intervals. During the 250 ms each input is applied to the instrument, its resistance is measured to 12-bit (1 in 4096) accuracy, and the corresponding digital word is recorded in serial format on 1/4" magnetic tape. In addition each record contains identity, time, and reference information; the reference being based on an internal fixed resistor.

The system uses a standard Nun-type buoy float, with a semi-taut chain-compensated mooring. To guard against the possible loss of equipment, a separate back-up marker-buoy is situated close to the FTP equipment.

The 4 systems will accumulate during IFYGL approximately 0.8×10^6 separate temperature samples. When the tape is retrieved, it is first "translated" from field-recorder format to standard computer-compatible format during which process a range of data-quality cnecks, and data-history entries,

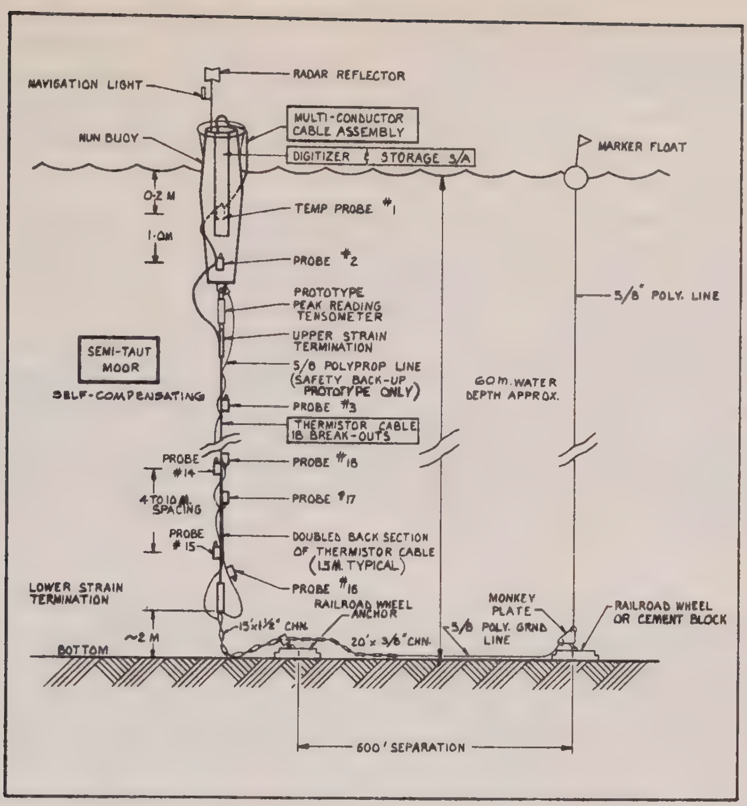

Figure 3. Lake temperature profiler. This is anchored at stations 3, 6, 9 and 10. The system uses a tape recorder.

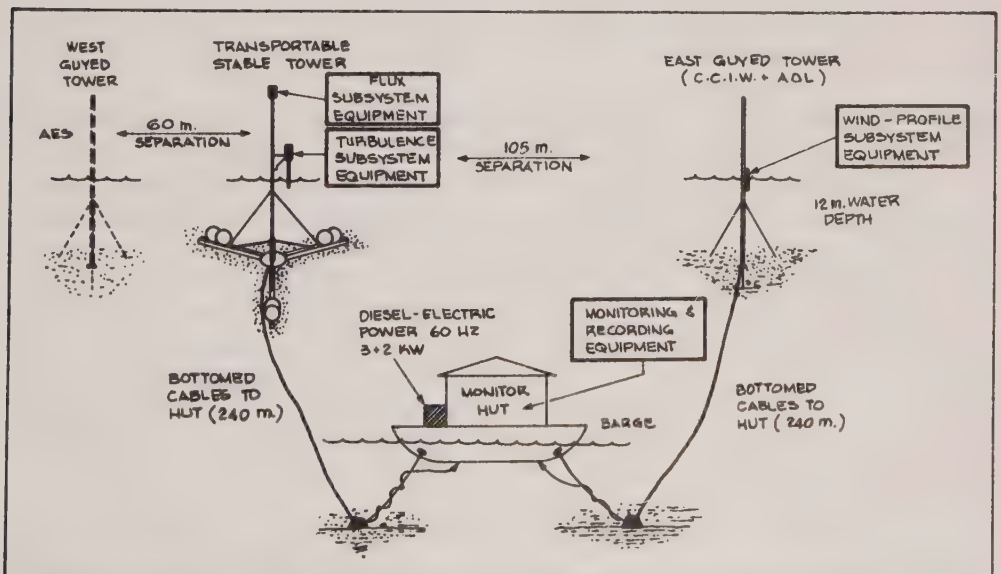

Figure 4. The micrometeorology mooring arrangement located off Niagara-on-the-Lake.

are made. Then the data is put in the IFYGL data bank, for subsequent detailed in depth scientific analysis.

Grounded Towers

The sensors are fixed to two bottom-mounted towers 2 km off Niagara-on-the-Lake (43° 16'N, 79° 08'W). The control and data-recording facilities are about 200 m from the towers. Interconnection between sensors and the hut-mounted equipment is by hardware link, using bottom-laid cables. The general arrangement is illustrated in Figure 4. The Atmospheric Environment Service and the Atlantic Oceanographic Laboratory also have systems nearby but not described here. There are 3 major subsystems, namely: the mean-profiling subsystem; the flux subsystem; and the turbulence subsystem. Each of these is a relatively complex multichannel data-acquisition system with its own recording facilities.

Mean-profiling subsystem. The mean profiling subsystem is a 16-channel measuring and data recording arrangement, with battery-powered recorder on one of the system towers, and a recorder-monitoring connection hard-wired to the manned monitor hut on the barge. In this subsystem the primary instruments are 5 pairs of temperature and windspeed sensors, logarithmically-spaced along a 30 ft (9 m) vertical array close to the water surface. A sixth similar sensor-pair is mounted as a roving probe on a motorised auto-recycling carriage, configured to travel along the 30 ft (9 m) array baseline and dwell at each of the 5 stations as required for calibration purposes. Of the 12 sensors so used, 6 are long time constant (greater than 3 s) thermistors operated only over 5 °C differential temperature range, but with 0.005 °C temperature resolution. The other 6 sensors are miniature cup-anemometers to measure windspeed which is integrated over the sampling period (10 minutes).

Other facilities in this profiling subsystem include a clamped wind-direction sensor to measure mean wind direction; and a clamped water-level sensor with potentiometric readout. An electronic clock provides both the 10-minute sampling pulses, and an elapsed time signal. The sixteenth input parameter is sensor station identity; a unique switched-in resistance value indicating which measuring station the moving probe has reached. The thermistor housings are aspirated. These 16 channels of the profiling subsystem are each sampled once per 10 minutes in a time-multiplexed mode, and digitized with 10-bit (1 in 1024) resolution prior to recording on a miniature battery-operated incremental tape recorder. Recorder capacity is 5×10^4 such data words, and data retrieval will occur once per month by physical recovery from the tower.

Routine monitoring is done by sending the recording-head current pulses along an 800 ft (240 m) cable to a chart-recorder in the monitor hut, where they can be both qualitatively and quantitively checked.

Flux subsystem. The flux subsystem is a 7-channel system, although, prior to final recording, a total of 15 functions are derived from the original 7 independent observations. The primary observations made are: horizontal air velocity; vertical air velocity; air temperature; and dew point. This system aligns itself into the prevailing wind direction. These 4 primary sensor signals are fed to a computer called a unit-parcel fluxmeter to yield 30-minute average values of each parameter plus average flux values of heat, momentum, and water vapour, by the eddy flux technique. The other three observations made are surface water temperature, water level, and wind direction.

The 15 parameters are computed over the 30-minute sampling interval and then serially multiplexed and recorded on 8-hole punched paper tape. The system endurance is approximately one month for a resolution of 1 in 10^4. The recording system for storing 24×10^3 such micrometeorological measurements. During the IFYGL a total of 1×10^5 such measurements from this flux subsystem is planned.

Turbulence subsystem. A rapid response turbulence sybsystem is also mounted on the central tower. It comprises 14 environmental sensors, plus 10 other physical sensors, whose measurements will allow detailed time-series analysis of the characteristics of the fluxes of heat, momentum, and water vapour.

A steerable sonic anemometer measures the 3 air-velocity components, and the results are tape-recorded in the frequency band from DC to 100 Hz. A 3-axis hot-wire anemometer is also used with facilities for direction control and tilt measurement. The orientation of both anemometers is controlled and measured at the monitor hut.

Additional sensing facilities in this turbulence subsystem include a Lyman-alpha hygrometer (with rainshield and heater) and an air temperature sensor. At the water surface there is a water-turbulence sensor array composed of 2 wave-height sensors to measure the instantaneous fluctuations in water-level, together with a 2-axis electromagnetic water-flow sensor. This sensor is mounted on a motorized roving probe with 18 ft (5.4 m) vertical excursion, servoed to the wave-profile to maintain a set depth below the instantaneous water level. Here, flow sensors, and the wave-height sensors, produce relatively low-frequency data (in the band DC to 50 Hz).

Data recording for this subsystem is flexible. The wide bandwidth signals (to 20 KHz) are direct-recorded on a 4-channel tape recorder for relatively short periods of particular interest. Signals of medium bandwidth (to 500 Hz) are direct recorded on a 7-channel instrumentation tape cassette machine. Up to 13 channels of DC to 50 Hz information are FM multiplexed so they can be recorded on a 4-track tape system, together with elapsed time signals from an electronic clock. In all several thousand hours of valid turbulence-related data are planned for acquisition by the turbulence subsystem during IFYGL.

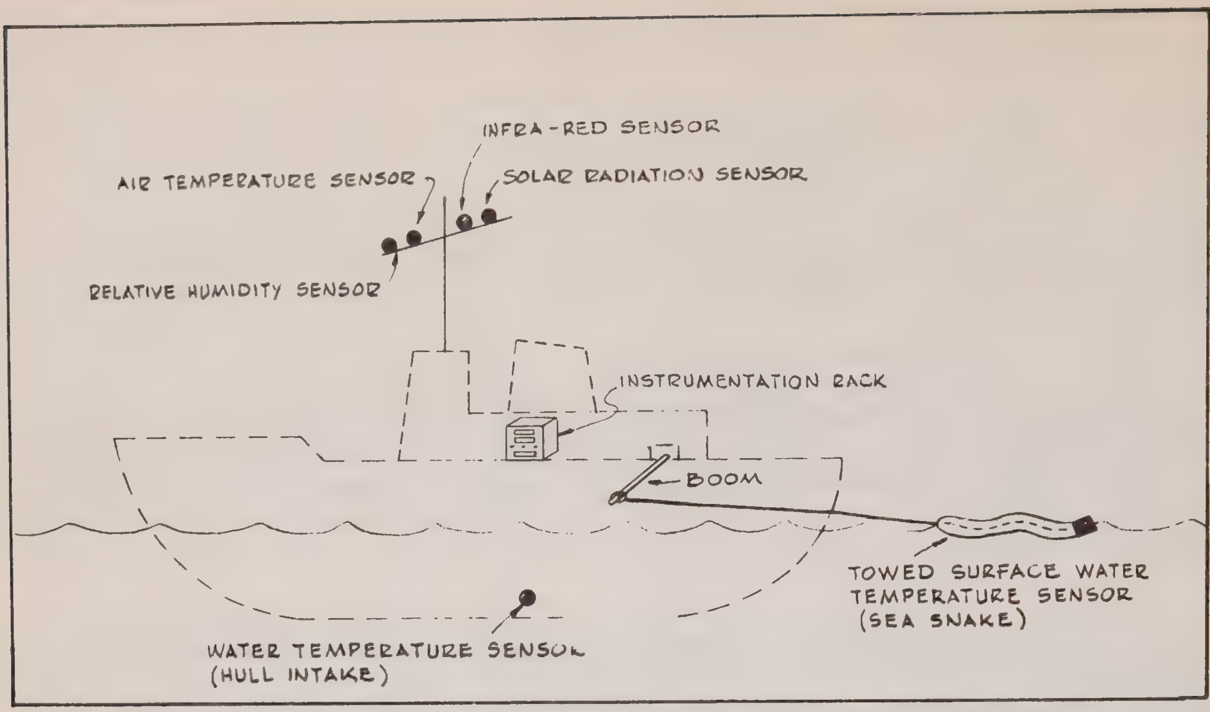

Figure 5. The data acquisition system of MV Martin Karlsen and CSS Limnos.

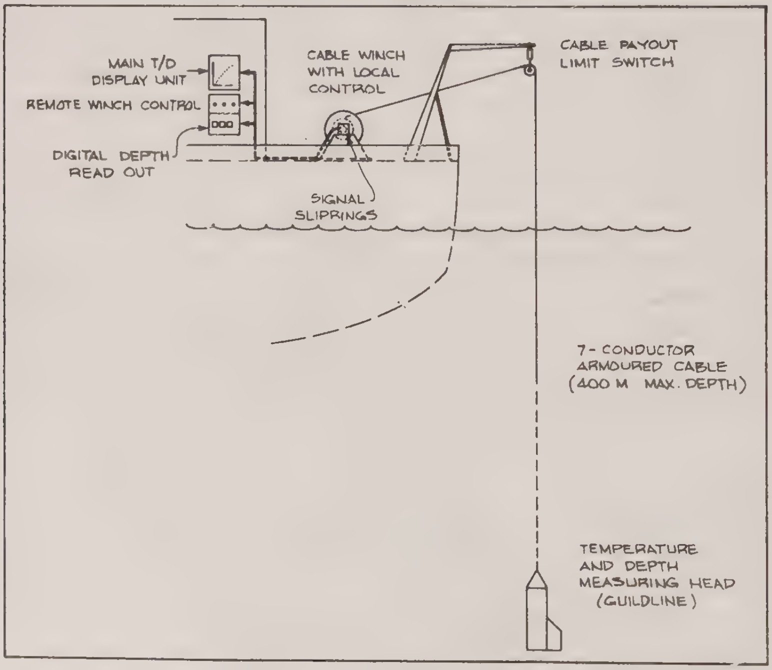

Figure 6. The electronic bathythermograph system as used on the MV Martin Karlsen and the CSS Limnos.

Data Acquisition System of MV Martin Karlsen and CSS Limnos

The system is designed to record surface water temperature, hull water temperature, air temperature and humidity, global solar radiation, and infrared radiation. All sensors are connected to an instrumentation rack and recorded on several chart recorders, integraters, or printers. The locations of the components is illustrated in Figure 5.

Surface water temperature. The temperature of the water surface is sensed by a platinum resistance thermometer and continuously recorded on a single channel chart recorder to an accuracy of $\pm$ 0.2 ^{o}C over the range of 0 to 30 ^{o}C.

Hull water temperature. A platinum resistance thermometer is located in a pipe which draws lake water in from a depth of 2 m (Limnos) and 3.5 m (Martin Karlsen) below the surface. The temperature is continuously recorded on a single channel chart covering the range -2 to 28 ^{o}C.

Air temperature. A platinum resistance thermometer is placed in an aspirated radiation shield and mounted 18 m (Limnos) and 24 m (Martin Karlsen) above the water surface at the top of the main mast. The temperature is recorded over the range - 5 to 45 ^{o}C to an accuracy of $\pm$0.1 ^{o}C and single channel chart recorded.

Atmospheric relative humidity. A lithium chloride variable resistor is used for a sensor and is mounted in an aspirated duct near the air temperature sensor on the main mast. Observations are recorded on a single channel chart recorder to $\pm$3% over the range 10% to 99% R.H., between 4 and 50 ^{o}C.

Radiation system. Two instruments are used, each is mounted high on the mast away from any shadows, temperature compensated, and fitted in the British Meteorological Office Weather Ship gimbal. The solar radiation for the sun and sky is observed with an Eppley pyranometer which is connected to both a chart recorder and an integrater. The integrater is controlled by an electronic clock so as to provide a print-out of the amount of radiation, integrated over each hour. The infrared radiation is detected by means of an Eppley pyrgeometer sensitive only to that global radiation with a wavelength between about 3 and 50 μm. A chart record and an hourly integrated print-out is obtained using elements of the solar radiation system.

Electronic Bathythermograph

At CCIW a number of variants of these systems exist, but each integrated system is effectively composed of 2 subsystems - the probe subsystem, and the associated winch subsystem, as shown in Figure 6.

The probe or temperature-measuring subsystem consists of four separate units: the temperature-depth (T/D) probe; a five-conductor underwater cable; a shipboard T/D control unit; and an X-Y recorder display.

The typical winch subsystem on a larger ship includes: an electrically-powered winch to haul the cable; a boom to keep the probe well clear from

the immediate influence of the ship's hull: ancillary shipboard electronics providing depth-scale expansion and digital readout; slipring; remote control facilities for operating the system from the shipboard laboratory; and special near-surface and near-bottom switches.

The probe subsystem is essentially a 2-channel measuring system with inbuilt calibration facilities, designed to be independent of cable and supply voltage variations. The temperature sensor is a strain-free copper wire resistance transducer using fine copper wire loosely placed in a 1/16 in. stainless steel coiled protective tube, directly in contact with the water. System temperature accuracy is $\pm 0.02\ ^{\circ}C$ maintained over an operating temperature range 0° to $30\ ^{\circ}C$. Sensing response time is 0.2 s. Full-scale and zero-point calibrations are provided by substituting internal voltage sources for the probe. This system facilities testing.

The depth sensor pressure transducer (100 m or 400 m full scale) is a resistance bridge type, accurate to 0.5% over a range 0 to 400 m.

The basic measurement technique, used in both temperature and depth sensing is a chopped square wave charge-transfer process, which maintains accurate signals independent of DC polarization potentials and possible cable or path leakages. The system was conceived by T. M. Dauphinee of the National Research Council of Canada.

Final display of the temperature vesus depth profile is traced on specially printed 11 by 17 inch format paper.

The electrical winch can be controlled either at the winch or from the laboratory. Winch speed is adjustable over a lowering range 0.5 to 1.5 m/s. The boom is 20 ft (6 m) long on the larger CCIW ships and the large, 16 in. (0.4 m), diameter, block can be specially heated to prevent icing in winter use. The electrical signals from the probe pass through brass sliprings and steel wool brushes, immersed in oil.

The buffered depth signal is also used to limit winch operation between maximum and minimum depths. If the probe is in danger of going too deep and damaging the pressure tranducer, then the winch is stopped. The probe is also protected when winding "up" during retrieval. To improve the temperature resolution, the depth-scale can be expanded so that 40 m depth corresponds to full scale deflection. A mechanical limit switch, activated by a local discontinuity on the cable, stops the winch to prevent the probe from being drawn through the block.

In support of IFYGL, CCIW will be fielding a total of 14 EBT systems, all functionally similar but with many individual variations. These systems are scheduled to produce approximately 5×10^{3} EBT profiles during the program, for a variety of scientific applications.

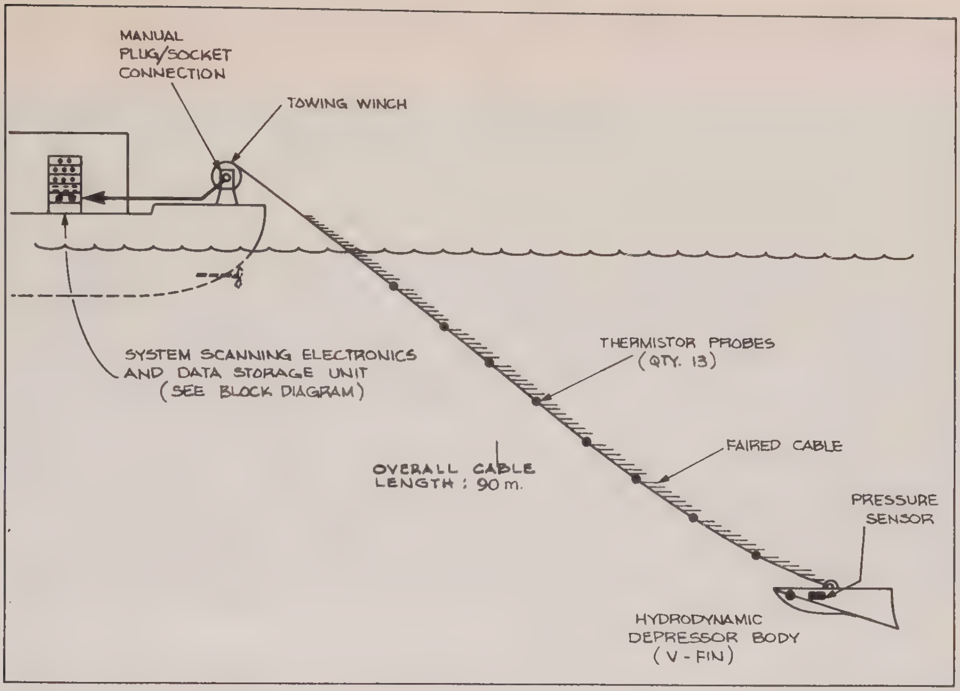

Figure 7. Towed temperature profiler system used to measure the temperature structure of the lake.

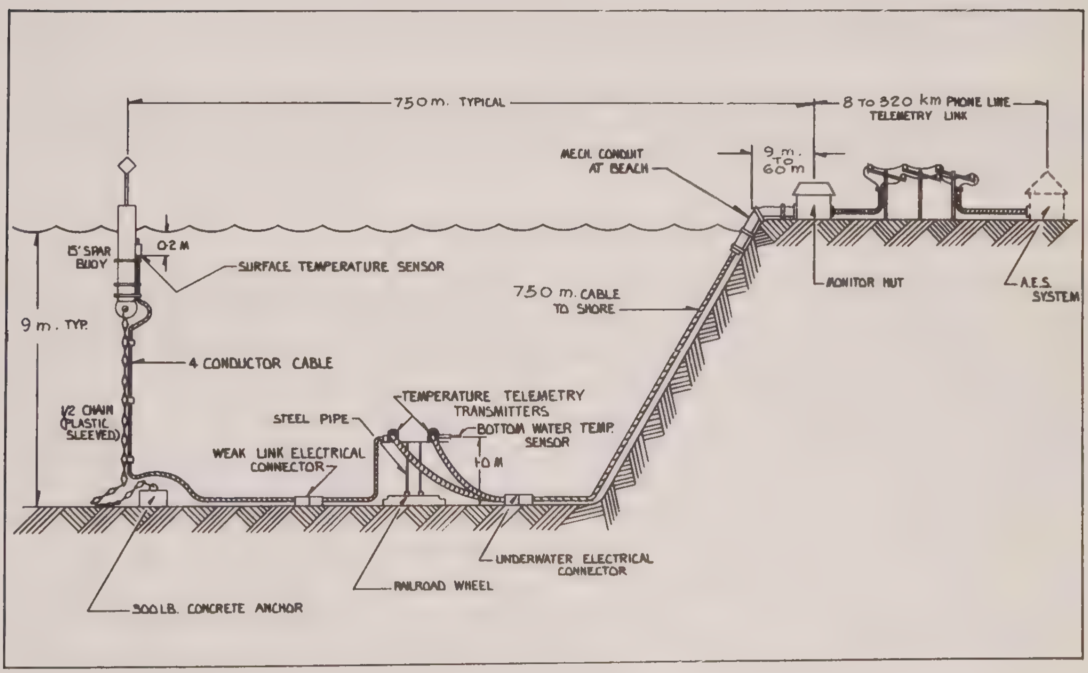

Figure 8. The mooring configuration of the shoreline temperature measuring system, which is located at the seven positions indicated in Figure 1, IFYGL Bulletin 2.

Towed Temperature Profiler

The Towed Temperature Profiler (TTP) is a specially developed 15-channel shipboard instrumentation system capable of acquiring and storing water temperature profile information directly on computer compatible 1/2 in. magnetic tape. The system's physical arrangement is shown is Figure 7. Thirteen of the fifteen input signals derive from fast-response thermistors equally spaced along a towed, faired, underwater cable assembly as shown in Figure 7. The time constant of the thermistors is 0.1 s, compatible with the one second sampling interval of the overall system, used at its highest resolution. The fourteenth channel of the system comprises depth information, derived from a pressure transducer in the hydrodynamic depressor body (a 6 ft. (1.8 m) V-fin) at the lower end of the cable. The fifteenth input parameter is cable tension measured by a load-cell mounted on the winch. The cable assembly is a two part system, the first being an electrical member which positions the thermistors and transmits their resistance values to the main electronic assembly on board the vessel. The second is a stainless steel zero torque strain member which takes the towing stresses. The two members together are sheathed by streamlined clip-on plastic fairing, to reduce drag, cable vibrations, and other towing problems.

The signals from the fifteen sensors of the system pass via the winch connection and suitable buffer amplifiers into the multiplexer stage - a reed-type scanning switch arrangement which can be operated at preset scan rates up to a maximum of a one scan per second. Subsequently, they pass through conventional analog to digital processing, and are formatted into standard computer compatible 1/2 in. tape format. Final data recording is accomplished on a high speed incremental tape recorder.

The system is sufficiently flexible to permit changes or additions to the channel capacity, word length or digital resolution, frame structure, and reference marks or status signals.

Shoreline Temperature Gauging Installations

The system purpose is to provide long term water temperature information at seven stations located around the Canadian portion of the Lake Ontario shoreline. Each shoreline station features a 2-channel temperature measuring and recording system, configured generally as shown in Figure 8. One temperature sensor of the system is installed 1 m above lake bottom. The sensor is fixed to a 750 lb (340 kg) railwheel platform in water 10 m deep. The second sensor, set at a depth of 0.2 m, is moored directly above the first and fixed to an 18 ft (5.4 m) spar buoy. The spar buoy is slack moored to a concrete block anchor, such that seasonal water-level changes are automatically taken up. The distance from the measuring point in the lake to the recording hut on the shore is typically 2000 ft (600 m), but varies between 600 ft and 3000 ft (180 and 900 m) depending on the site location.

The temperature-measuring networks used consist of a platinum resistance sensor; a temperature transmitter unit; a DC power supply with read-out

resistor installed in the DC return line; and an analog chart recorder.

The sensor is a platinum resistance element with an "Ro" of 100 ohms and a span of 25 ohms. Time constant is 5 s in water with a velocity of 3 ft/s (0.9 m/s). Dissipation constant is 40 mW/$^{\circ}$C in water with a velocity of 3 ft/s (0.9 m/s).

The transmitter unit for the temperature signal essentially consists of a precision resistance bridge network, plus an error amplifier producing constant current output linearly proportional to temperature value. This unit provides an output signal effectively independent of cable resistance, length, or resistance variations from any cause.

Regulator circuits also isolate transmitter operation from any supply or voltage drop variations. This temperature-measuring system operates from -15 to 35 $^{\circ}$C with an accuracy of $\pm$ 0.15 $^{\circ}$C, and produces a temperature-related output current to a maximum of 20 mA DC. Electronics are oil immersed, at ambient pressure.

Data recording is done on a 2-channel strip chart recorder accurate to $\pm$0.2% of fullscale deflection. The recorder input voltage is generated across a precision resistor in the return line of the operating power source. As the temperature is being measured over a long term basis, chart speed is 1 in./hour giving system capacity for unattended operation for about 30 days.

The complete instrumentation system (including recorder) for each of the 7 stations in use during IFYGL is calibrated in 5° steps from 0 to 30 $^{\circ}$C in a calibration bath.

Approximately 5×10^4 hours of valid temperature record is scheduled to be produced by this network of shoreline temperature stations.

Atmospheric Environment Service Systems

Core Data Set

Shoreline Network. The output from each sensor is amplified, digitized, encoded, and recorded on eight-level punched paper tape and teletype hard copy. The sensor array is scanned at 10-minute intervals upon the command of a digital clock. During hydro power failures, the data-logging system will not function, but the clock has an emergency power supply so that the accounting of time is continuous. The sensors are:

(a) for air temperature, an 100 ohm platinum resistance bulb in an aspirated Stevenson screen (time constant 15 s, resolution 0.06 $^{\circ}$C, absolute accuracy $\pm$ 0.25 $^{\circ}$C);

(b) for dew-point temperature, a miniaturized dewcell in the aspirated screen (time constant 60 s, resolution 0.1 $^{\circ}$C, absolute accuracy $\pm$ 0.5 $^{\circ}$C);

(c) for wind components, propellers with a cosine response mounted orthogonally on a 10 m mast integrating the wind during the readout interval (distance constant 3 m, starting speed 0.3 m/s);

(d) for precipitation, a volumetric raingauge in a 10 in. (254 mm) diameter tipping-bucket shell, mounted as close to the ground as conditions will permit (resolution 0.01 in (.254 mm), sensor accuracy $\pm$ 1% but seriously undercatches with respect to a pit gauge at high wind speeds);

(e) for pressure, a Kissler force-balance transducer biased to operate over the 950 to 1050 mb range, located with the electronic and recording equipment to keep environment temperature within the allowable range (resoltuion 0.1 mb, with potential errors summing to about 1.0 mb).

Bedford Towers. The Bedford Towers (Figure 9) were designed by the Atlantic Oceanographic Laboratory. They are taut-moored spar buoys. The sensors are the same as those described above with the following exceptions and additions. The system is illustrated by Figure 10.

(a) temperature, dewpoint, and wind components will be sampled at three levels, about 25, 37, and 55 ft (7.6, 11.3, and 16.8 m) above water level;

(b) temperature sensors will be mounted in flat-plate radiation shields, naturally ventilated giving a time constant of 30 s;

(c) the dewcells are mounted in specially designed convectively ventilated shields, plus radiation shields, giving a time constant which is a function of relative humidity (2 minutes at high RH increasing to 15 minutes at 15% RH);

(d) the pressure transducer will be mounted below water and vented 6 m above water level. Initial installations will not include this sensor because

Figure 9. Bedford Tower.

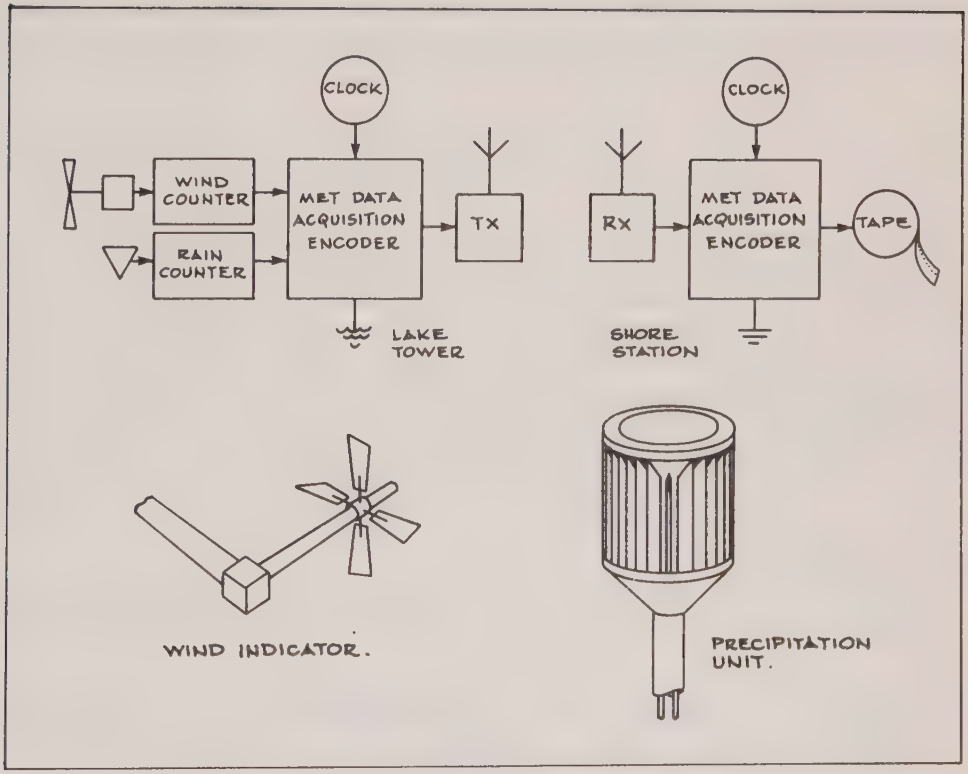

Figure 10. Block diagram of Bedford Tower instrumentation system. Data from the wind and rainfall sensors are fed continuously into individual counters. At 10-minute intervals the clock triggers the ENCODER into operation and the counters are read sequentially and transmitted as a serial pulse train to the shore station. Here it is decoded into ASCII and transmitted to teletype.

certain technical problems, especially regarding the power supply, have not yet been solved;

(e) the raingauge will be mounted at the top of the mast, and will have separate sensors for horizontal and vertical sampling orifices to permit correction for wind effects (a field test of this arrangement mounted at the top of a 10 m mast gave results surprisingly good with respect to the readings of a pit gauge nearby);

(f) the data will be digitized on the tower and transmitted by pulse-tone modulation of a 173.22 MHz carrier to a shore receiver.

Climatological Network. The existing climatological network in the basin consists of over 160 stations with different programs. Most will observe daily precipitation amounts; some maximum and minimum temperatures as well; and so on. The rostor at the end of 1971 was as follows:

(a) 90 stations made temperature observations, daily maximum temperature using a mercury-in-glass thermometer with a constriction to prevent return of the mercury to the bulb as the temperature falls, and daily minimum temperature with an alcohol-in-glass thermometer with a metal slug which is carried downward by surface tension but left behind when the column rises in response to rising temperature;

(b) 150 stations observe daily precipitation using an ordinary raingauge (10 sq. in. or 6450 mm^2) with a graduated cylinder for rain, and a snow ruler;

(c) 58 stations measure rate of rainfall with either a tipping-bucket raingauge (0.01 in. - .254 mm resolution) or a Fischer and Porter long duration precipitation gauge (0.1 inch - 2.54 mm resolution);

(d) 11 stations observe hourly wind mileage with a type 45B anemograph (after each mile of wind as measured by the cups, a pen steps on a chart, and the vane orientation is recorded to eight points using two pens);

(e) 6 stations observe pan evaporation using a class A evaporation pan and ancillary equipment;

(f) 9 stations use Campbell-Stokes sunshine recorders for duration of "bright" sunshine;

(g) At 3 stations, at least one of the components of radiation balance is observed using a suitable radiometer.

Airborne Radiation Thermometer. Observations of surface-water temperature are made weekly using an airborne infrared thermometer, Barnes PRT-5 or Barnes IT-3. Our analysis procedures result in relative accuracy of at least 0.5 °C., with the absolute accuracy better than 1.0 °C.

The arrangement of equipment inside the twin-engined aircraft is shown in Figure 11, this includes a black body reference source for in flight calibration.

IFYGL Radiation Network.

(a) Eppley precision I-R sensors have been acquired to supplement the existing pyranometers on the MV Martin Karlsen, the CSS Limnos and the CCGS Porte Dauphine.

(b) At four locations within the basin, total incoming solar and total incoming all-wave radiation will be observed and integrated hourly. The latter will be measured with a net pyrradiometer, modified to measure downward total global radiation by enclosing the bottom-looking sensor in a black-body cavity of known temperature.

(c) Kipp and Zonen solarimeters borrowed from the State University of New York at Albany will be the pyranometers mounted on the Bedford Towers.

(d) Data from the IHD network of net pyrradiometers near Bowmanville will be available.

Ice Reconnaissance. Visual observations of ice cover will be made by observers in the ART aircraft and the regular ice reconnaissance aircraft.

Joint Scientific Programs

The programs noted here are joint and fully coordinated internationally. Because the data-acquisition systems are virtually identical to those being used by U.S. participants, little descriptive material is necessary here.

Atmospheric Water Balance. Three stations in Canada will be equipped with the Beukers LO-CATE system which uses LORAN-C navaid system signals for positioning, and hence, windfinding. This system observes winds many times more accurately than standard GMD equipment, with an RMS error of only 0.5 m/s. Precision sensors in the sonde will provide more accurate temperature, humidity, and pressure measurements than from a standard sonde.

Evaporation Pan Network. At three locations on the Canadian side, Class A pans and experimental, insulated X-3 pans will be operated side-by-side. Details of these are provided in the U.S. write-up of this project.

Precipitation Radar Program. Digitized radar reflectivities will be calibrated using raingauge data to provide precipitation estimates throughout the basin. The Canadian radar to be used is the C-band research set at Woodbridge. A CAPPI programmer has been installed and is operational. Photographs taken at 3-minute intervals will be digitized and integrated using a photoscanning device and ancillary PDP-9 computer.

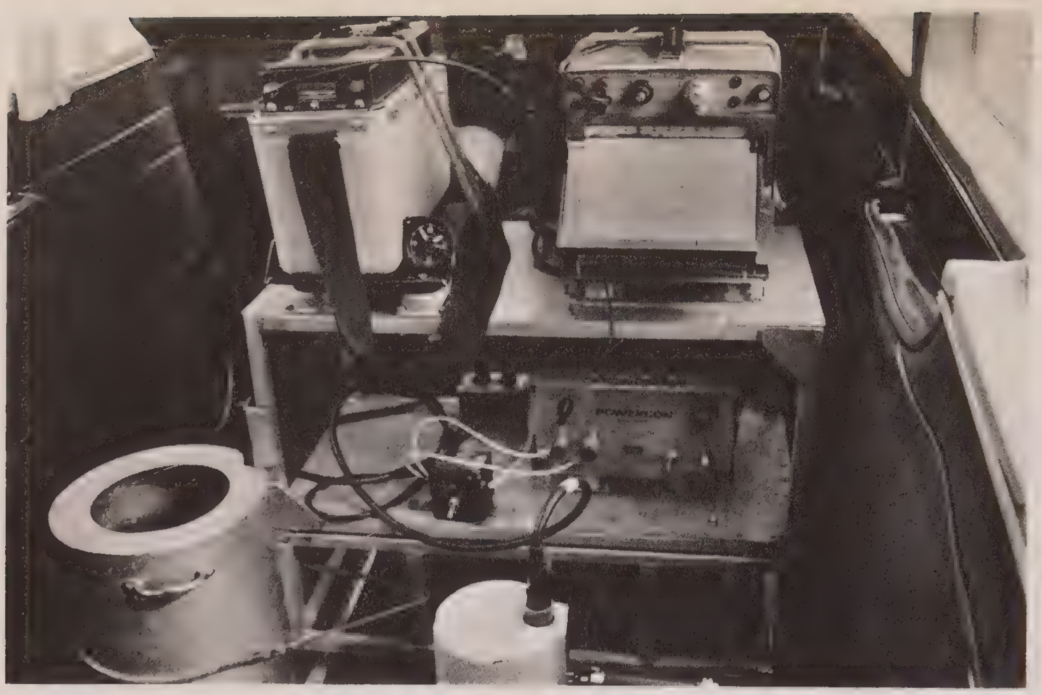

Figure 11. Arrangement of ART equipment inside aircraft.

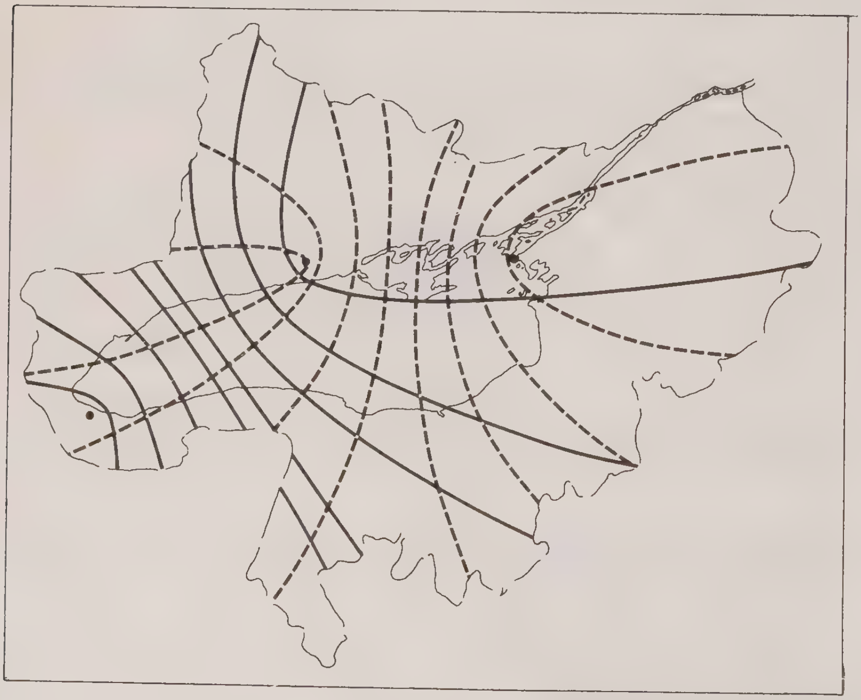

Figure 12. Coordinate lines of the Decca navigation system. The solid curves are the position lines generated by the Master and Red Slave and dotted curves are the position lines generated by the Master and Green Slave.

Micorometeorological Program

A comprehensive program of micrometeorological measurements from towers and other platforms will be undertaken. Equipment to be used includes, inter alia, sonic anemometer, Lyman-α humidiometer, Gill propeller anemometers, refractometer, precision wet and dry thermocouples, resistance thermometers, microbead thermistors, radiometers, and a capacitance type wave probe. Flux and profile measurements and calculations will be made by several techniques. Full details of these special instruments are contained in the Technical Plan, Vol. 2.

Summary

The Atmospheric Environment Service is providing a broad spectrum of Atmospheric sensors and data-acquisition systems. Some are standard network equipment, but others are new and specialized. For this latter category, new data systems must be developed for the quality control, archive, and analysis functions.

IFYGL Position Fixing System

The location of IFYGL observations in the Lake Ontario basin is determined by means of the Decca Lambda (6f) Hyperbolic Survey System. This establishes a single electronic grid of intersecting position lines (or Decca Lattice), over the basin which can be used by an unlimited number of land, sea, or airborne vehicles. The Decca Lattice is shown in Figure 12.

After a joint study of all systems, the IFYGL System was selected by Canada and the USA from the various Decca Systems which have been in world-wide use for the past 25 years. It is therefore a system of proved reliability and accuracy which is optimized for use in the Great Lakes. The system is supplied, operated, and maintained by the Survey Division of Computing Devices of Canada and is provided by the Marine Sciences Branch of Environment Canada in partnership with the United States National Oceanic and Atmospheric Administration.

How it Works

Three phase locked continuous wave (CW) radio transmitters generate the coordinate system or Decca Lattice. The Master and the Red Slave generate the red set of position lines; the Master and Green Slave generate the green position lines. The radio frequencies of the CW transmitters are harmonically related so that CW phase comparison can be achieved. The transmission frequencies used are:

Master 84.730 KHz
Red Slave 112.973 KHz
Green Slave 127.095 KHz

The mobile observer is a radio receiver which continuously observes the phase differences between the Master and the two Slaves. These two phase differences are displayed or recorded on a clock-faced instrument called the

Decometer. Each reading of the Decometer corresponds to a particular position line and hence the vehicle location is established. A 360 degree rotation of the Decometer corresponds to a distance of about 500 m on the base line; this is the lane width. Rotations of the Decometer are counted and indicated. These These indications can be recorded by printers or plotters.

How it is Used

The system is available for use by landl sea, or airborne vehicles. At the commencement of the survey, or when passing by a known point, the two Decometers are set to show known Decca Lattice readings. From then on, the Decometers continuously display the Decca Lattice coordinates.

The Decca Lattice coordinates are transformed to geographic coordinates by computation or by using a set of charts or plotting sheets. Two scales of plotting sheets are available: a 1:400 000 scale chart covers the area of the basin north from 43° N to 44° 30"N, and west from 76° W to 80°W; eight 1:80 000 charts cover the areas shown in Figure 13. The charts show both polyconic and Universal Transverse Mercator (UTM) grids.

Reference Buoys - Decca Moorings

In land areas of the basin, any convenient known point can be used as the reference point for the initial Decometer setting. To facilitate operations in the Lake, a set of 12 Decca moorings are established around the periphery of the Lake as shown in Figure 14. The Decca coordinates of these moorings together with their approximate geographic locations are given in Table 2.

These buoys are steel spar type fitted with radar reflectors and painted with vertical yellow and orange stripes.

Accuracy

The ultimate accuracy that can be achieved with radio positioning systems in offshore areas is highly dependent on a number of factors, some of which the user can control, such as frequency, site selection, etc. However, the major variable factor is the speed of propagation of electromagnetic radiation, with the conductivity of the water ranking high among the contributing agents affecting propagation. The plotting charts are based on a propagation speed of 299.4 Mm/s.

By monitoring the pattern and the determination of "Fixed Errors" we hope to obtain higher accuracy than is usually mathematically predicted.

The IFYGL Decca 6f Hyperbolic Survey System cannot produce the very high accuracy associated with shorter range systems nor the very long range capacity of some other systems. However, it does cover all of the Lake Ontario Basin with an accuracy acceptable to all participants in the Field Year.

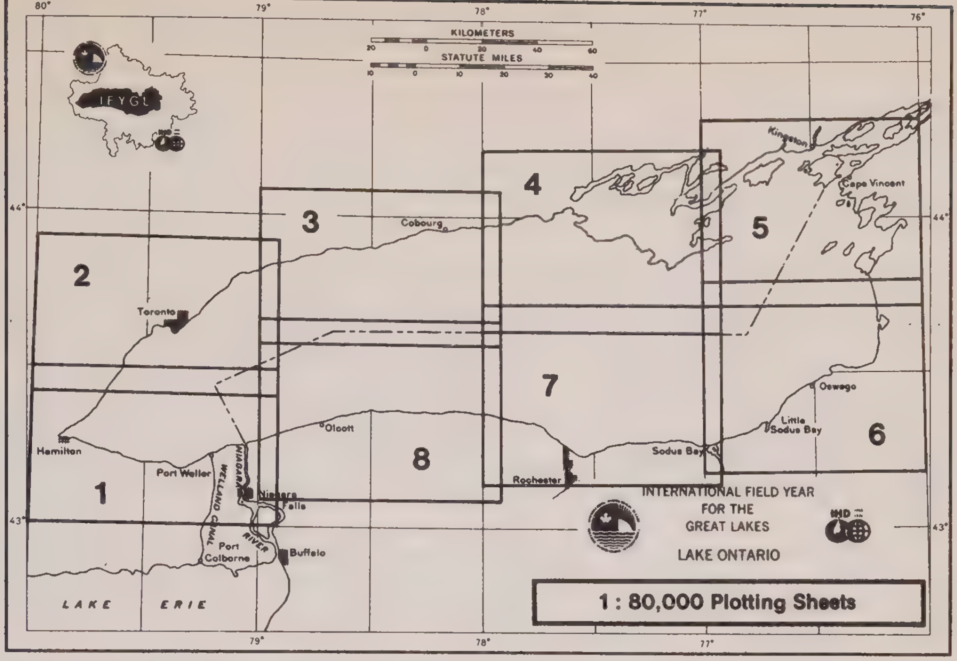

Figure 13. The basin areas covered by the large scale 1:80 000 plotting sheets.

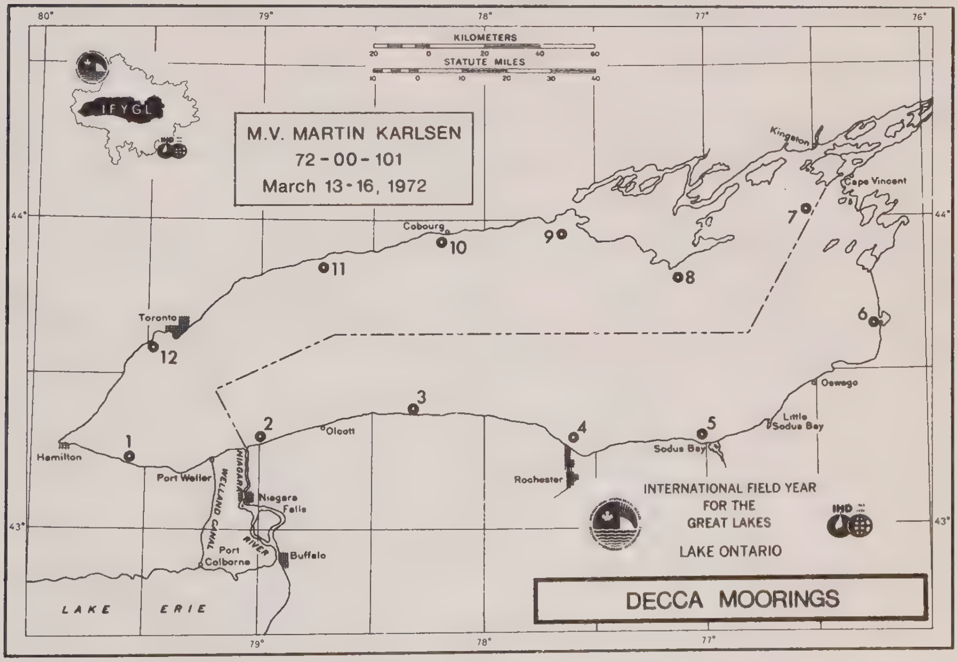

Figure 14. Locations of steel spar Decca reference buoys. These are painted with vertical yellow and orange stripes and are fitted with a radar reflector. Decca lattice coordinates are given in Table 2.

Marine Sciences Branch representatives - F. L. DeGrasse and P. Brunavs (Nautical Geodesy) - in conjunction with I. Thompson, Systems Specialist for Computing Devices of Canada have collectively developed a program for "Phasing-in" and determining fixed error corrections by calibrating at strategically located positions around the periphery of the lake. A representative from NOAA, (Mr. W. Bergen), National Oceanic Surveys, USLS in Detroit Michigan is participating in the project.

The system was activated and fully operational on April 2, 1972 "Phasing-in" and fixed error calibrations at six of the ten selected positions around the periphery of Lake Ontario were completed as of April 5, 1972. The MV Martin Karlsen is continuing the "Fixed Error Calibrations" under the control of Mr. F. L. DeGrasse, the Hydrographer-in-Charge, Great Lakes Systems, with every expectation that all "Fixed Error Calibrations" will be concluded by April 10 1972. Results obtained to April 5, 1972 are considered excellent. The calibration data will be published shortly and suitably distributed.

These fixed errors will be checked from time to time during the year to ensure that maximum possible accuracy is maintained. The corrections will be communicated to all users without delay.

The purpose for carrying out "Fixed Error Calibrations", which are complimentary to "Phasing-in" the system, is to provide a check on the speed of propagation of electromagnetic waves over fresh water. Conductivity of the surface water of the entire lake at known points has or will be measured at existing surface water temperatures during the period April 3 to 9, 1972. Phase lag, hence absolute positioning accuracy, is highly dependent on this factor.

Table 2. Decca Coordinates of various reference locations and of the special set of Decca Moorings shown in Figure 11

Reference Point of Decca Buoy Number	Water Depth (m)	Red	Green	Location North Deg.	Min.	Sec.	West Deg.	Min.	Sec.
Karl		E12.43	A36.76	CCIW Quay Wall					
1	22	E14.32	A39.13	43	15	09	79	35	06
2	21	A13.92	A43.98	43	19	24	79	00	00
3	21	G04.50	B40.73	43	23	30	78	18	24
4	22	E03.76	E32.43	43	17	51	77	35	48
Shell	21	D22.69	A36.01	2nd cell from end of Shell Oil Wharf at Bronte					
5		Not available		43	17	54	77	01	39
6	22	B15.24	A37.65	43	37	09	76	14	15
7	21	A16.42	A45.21	44	01	36	76	33	12
8	20	B03.57	F44.30	43	49	12	77	13	48
9	20	A15.40	C40.35	43	56	30	77	40	12
10	21	C03.78	A33.61	43	55	24	78	13	00
11	22	F21.06	A31.97	43	50	36	78	44	54

Table 2 (concluded)

Reference Point of Decca Buoy Number	Water Depth (m)	Red	Green	Location					
				North			West		
				Deg.	Min.	Sec.	Deg.	Min.	Sec.
12	21	B12.27	A33.47	43	35	36	79	28	30
Wharf, Oshawa		G05.24	A31.31	Corner of Wharf					
Wharf, Oshawa		G05.24	A31.31	Mark on Wharf Near Inner Range Light					
Wharf, Oshawa		G05.14	A31.36	Entrance to Harbour					
Wharf, Rochester		E09.67	E32.54	Monroe County Wharf					
(1) West Light		E08.22	E32.97	At entrance to Rochester Harbour					
(2) Bisector (Between E & W Light)		E08.28	E32.95	At entrance to Rochester Harbour					
(3) East Light		E08.34	E32.96	At entrance to Rochester Harbour					

The Canadian Data Management philosophy or policy is to make all quality controlled IFYGL data, data products, and data support information available to any interested persons as easily and as inexpensively as possible.

The archive is classically structured: the highest level, level 1 - a catalogue-lists what data are available; the next or second level a condensed summarized data file, or "mini" file; likely on magnetic tape, hard copy, or microfilm, and the third level is a magnetic tape file of observational data which has been checked and verified. In principle the Data Archiving Centre does not handle raw data. The collection agency processes the raw data prior to entry into the archive. A mechanism for storing raw data at the archive site is provided in such cases where retention of raw data is relevant to future users and there is no guarantee of retention by the investigator.

The following binational policy agreements have been reached by the IFYGL National Data Centres for both Canadian and United States data.

(a) The United States will publish a catalogue or data index of all IFYGL data.

(b) Canada has agreed to take on the responsibility for compiling and making available at cost the summarized data file or condensed "mini" file which can be reproduced on tape, hard copy, or microfilm.

(c) Each country will maintain their own in extenso data files and exchange these on demand.

The second level of the data or Summarized Data File, which is a special responsibility of Canada for both Canadian and United States data, provides compact storage. The form is both cheap to obtain, easy to use, and scientifically useful. This level of data will consist of data which has been summarized, laid out in tabular form in most cases, and then stored on microfilm and magnetic tape. This level of data has three purposes:

(a) To provide easily accessible, easy to use and inexpensive data;

(b) To provide scientifically valuable data for analysis and work without the need to go through the vast amounts of original data; and

(c) To provide a way to determine events of interest and hence, give access points to the Main Data Bank.

At present, requirements for lead sheets and summaries, and in speoifying data to be included in the summaries, are being prepared.

METHODS OF TAXONOMIC IDENTIFICATION AND ENUMERATION OF PLANKTON

Report of a Workshop held at CCIW on 26 and 27 January 1972
Dr. M. Munawar, CCIW

Plankton research in the Great Lakes has been receiving more attention during the past few years. It is encouraging to see that several people have become relatively more interested in plankton taxonomy in view of its role in the understanding of eutrophication. Drs. A. Nauwerck and M. Munawar from CCIW, the convenors of this meeting, felt that in view of the IFYGL there was a great need for a workshop to discuss the various methods and techniques used for sampling, taxonomic identification, and enumeration of Great Lakes plankton. They also felt a need to establish permanent contacts between plankton researchers.

Phytoplankton Discussion Group

Various aspects of phytoplankton research were discussed, including field and laboratory methods. The participants also discussed at length the following aspects of general concern and agreement was reached in certain areas but differences of opinion were obvious in others:

> samplers, pumps, sampling depths, relative merits of replicate sampling, preservatives, various problems of phytoplankton taxonomy and enumeration techniques.

The absence of some U.S. participants in the IFYGL program was felt at the meeting. The two major laboratories involved so far in the IFYGL program for phytoplankton taxonomy seemed to follow their own techniques which are described below.

Techniques used at Great Lakes Division, University of Michigan, Ann Arbor (Dr. E. F. Stoermer)

Phytoplankton samples are fixed in glutaraldehyde, filtered onto 25 mm "AA" Millipore filters and semi-permanent slides are prepared by clearing the filters with beechwood creosote. The prepared samples are then identified and enumerated by using a standard research microscope with homogenous immersion system of at least 1.30 N.A.

Techniques used at Canada Centre for Inland Waters (Dr. M. Munawar)

Phytoplankton are counted using Utermöhl's inverted microscope technique (Utermöhl 1931, 1958); the method has many advantages (Lund, 1951). At the same time it is recognized that high resolution is not achieved. This may be required in some cases for the identification of diatoms, especially in counting the striae. To count striae, the diatom slides are prepared and the diatoms are identified under oil immersion, either on the inverted microscope or by a regular compound microscope (magnified 1500x); but the enumeration of diatoms is done along with other types of phytoplankton in the sedimentation chambers using an inverted microscope. Such a combination of techniques, which has been followed since 1969 at CCIW, may be better. The phytoplankton, preserved in Lugol's solution, are enumerated using Utermöhl's technique. Another portion of the sample is also kept at the temperature of the lake for later study and identification of the organisms in living conditions, particularly to facilitate the flagellate identification. It should be noted that by using Utermöhl's technique, Cryptomonadinae were found to be the second most important group by volume in Lake Ontario, and flagellates (Cryptomonadinae, Chrysomonadinae, Dinophycinae) comprised almost 48% of the total biomass by volume in the eastern end of Lake Erie. It is important to use a procedure that counts not only the dominant species but also the uncommon species. Attention is paid to these uncommon algae because these species may be significant when the total biomass of various taxonomic groups is considered such as Chlorophyta, Cyanophyta, etc. The procedure of stratified counting is described below:

(a) four or five most common, larger phytoplankton species are established by scanning the entire chamber;

(b) only these selected species are then enumerated in two strips or transects in low power (300x);

(c) the uncommon species of larger phytoplankton are then enumerated under low power (300x) and the whole chamber is scanned;

(d) The nannoplanktonic species are counted in two strips under high power (600x). The oil immersion objective (1500x) is used to facilitate identification. The procedures of CCIW will be published by Dr. Munawar.

Errors of Enumeration and Statistical Considerations

Enumeration results could be affected by several types of errors, e.g. subjective errors (commonly made) and statistical errors. Lund *et al. (1958)* and Javornicky (1958) have discussed in detail the statistics of enumeration. Margalef (1969) has discussed the problems of plankton enumeration.

Taxonomic work is time-consuming, consequently some workers do not consider it practical to count at least 100 individuals of each and every species in a sample as recommended by Utermöhl. On the other hand Nauwerck (1963) is of the opinion that Utermöhl's recommendation can apply to the most common species because, as one keeps counting, rare species keep appearing and the

time spent in enumeration should be reasonably proportionate to the results. Lund *et al.* (1958) and Javornicky (1958) give 200/ $\sqrt{n}$% as the counting error which is not exceeded for more than 5% of the time, where n is the number counted assuming uniform division; this is used at CCIW. Thus to achieve 12% accuracy at least 300 units or entities are counted where colonial forms are considered as a single unit or entity for enumeration purpose. If an entity has more than one cell, the number of cells per entity are also recorded.

Pigment Extraction Methods

After discussing various techniques the following major conclusions were agreed upon and recorded by Dr. W. Glooschenko:

(a) Filter water sample, nominally one liter, through Whatman GF/A or GF/C filter. Suction not to exceed 10 in. Hg (339 mb). A $MgCO_3$ suspension to be added preferably before sample added to improve retentivity of plankton. Amount should be approximately 5 ml. If filters clog due to high algal biomass, then the $MgCO_3$ can be added at the end of filtration.

(b) Filter to be frozen at 10 to -10 $^{\circ}$F (-12 to -23 $^{\circ}$C), dessicator optional. Labelling of filter *not* to be done with ink.

(c) Filter removed and excess filter trimmed (optional). Grind with teflon pestle in glass mortar homogenizer with 90% acetone (diluted with water). Room temperature for grinding, but in subdued light.

(d) Make extract to volume (10.0 ml) in calibrated 15.0 ml centrifuge tube if 10 mm path length cuvette used. If 40 or 50 mm cuvette used, make to 15 ml. Place in dark for approximately 1 hour at room temperature.

(e) Centrifuge for 10 minutes at approximately 3000 rpm. Recommend swinging-head type centrifuge.

(f) Determine absorbance values at 750, 663, 645 and 630 nm with 40 or 50 mm cells. Minimum absorbance should be 0.2 for pheo-pigment analysis.

(g) Calculate chlorophyll value by SCOR/UNESCO equations (Strickland and Parsons 1968). Only chlorophyll a needed for most IFYGL work.

(h) Determine pheo-pigments by method of Lorenzen using 2 drops in HCl solution (Strickland and Parsons 1968).

Zooplankton Group (Dr. N. Watson)

Field and laboratory problems associated with the collection, identification, enumeration of zooplankton in the Great Lakes and presentation of the collected data were discussed. Not all of the participants in IFYGL programs were present, and it was realized that the varied nature of the projects to be undertaken precluded the development of standard sampling methods or laboratory procedures. In fact, pumps, nets and water bottles are suggested as sampling devices. However, the importance of achieving

methods of calibrating gear and replicating sampling was agreed upon, as well as providing the means for readers of published reports to convert data from one type of unit to another.

It was agreed that there should be an exchange of specimens between laboratories identifying zooplankton to make sure that difficult taxa are being identified in a consistent manner and that the standard reference works should be used by all investigators.

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THE IFYGL COOPERATIVE FISHERY SURVEY

W. J. Christie

The fish stocks of Lake Ontario are more seriously depreciated than those of any of the other Great Lakes. Lake Erie has suffered through the loss of many premium fish stocks as well, of course, but the commercial fisheries have continued to find fish to catch in quantity. In Lake Ontario no substitute species arose after the disappearance of the lake trout, deep-water ciscoes, and whitefish, and the offshore commercial fisheries collapsed. The fishery has only persisted in the eastern outlet basin and Bay of Quinte region where the commercial yield has been maintained at a fairly uniform level by increasing reliance on nearshore fish like perch and eels. It is a striking fact that the main trench of the lake produces virtually no fish of sporting or commercial value, at present. The changes in the fish fauna have been variously attributed to the effects of overfishing, cultural eutrophication, colonization by new species like American smelt, and the sea lamprey.

In spite of this rather dismal picture there are some grounds for optimism. We know for example, that water quality in the lake is still sufficiently good to produce excellent growth and survival in planted salmonids. It is anticipated moreover, that the expected reduction of phosphate loading will have profound biological consequences, and may well result in appreciable habitat improvement for quality fishes. Present and future demands for recreational fishing moreover, make it imperative that all efforts possible be made to restore the lake to productivity. To this end the management agencies have undertaken to control the abundance of the sea lamprey, and have begun a re-stocking program.

This renewed interest in the fishery resource potential of Lake Ontario has made research into a number of vital questions necessary. Among these questions:

(a) What is the present status of the fish fauna, especially in the central and western areas where fishing is no longer carried out. Are there reserves, for example, of deepwater ciscoes which in the right conditions could repopulate the lake?

(b) What sort of on-going monitoring program will suffice to evaluate the results of the management initiatives in the absence of fisheries whose catches can be monitored?

(c) Most important, what are the present food chains in the lake and how best can we take advantage of, or alter them, to recreate a productive ecosystem?

These questions were becoming increasingly urgent as the Field Year drew near, and it was natural that the fishery biologists of the concerned agencies would see the advantages of:

(a) joining forces to seek answers, and of

(b) doing this work against the unique background of environmental information collected by the physical programs of IFYGL.

The program planned for 1972 entails systematic fishing with a variety of gears. It attempts to obtain synoptic descriptions of distribution patterns of various species over the whole lake bottom at various seasons, and to intersperse such observations with spatially limited studies of vertical distribution. The examination of the fish collected will give special attention to feeding habits to try to define the major vectors of materials transport.

The principal agencies involved in the study are the Ontario Ministry of Natural Resources, the U.S. Bureau of Sport Fisheries and Wildlife and the New York Department of Environmental Conservation. The cooperating units and principal investigators are as follows:

Ontario Ministry of Natural Resources (OMNR)

Glenora Fisheries Station	Picton, Ont.	W. J. Christie
Lake Erie Fisheries Station	Wheatley, Ont.	S. J. Nepszy
Southern Research Station	Maple, Ont.	K. H. Loftus
L. Ont. Fish Mgt. Unit	Richmond Hill, Ont.	J. E. Byrne

U.S. Bureau Sport Fisheries and Wildlife (USBSFW)

Great Lakes Biological Lab.	Ann Arbor, Mich.	A. Larsen
Lake Erie Research Station	Sandusky, Ohio	W. F. Hartman

New York Dept. of Environmental Conservation (NYDEC)

Cape Vincent Research Station	Cape Vincent, N.Y.	G. LeTendre
Regional Office	Watertown, N.Y.	L. Blake
Regional Office	Scottsboro, N.Y.	N. Holmes

The offshore program is being carried out by the U.S. vessel Kaho (see Figure 15), and R. V. Cottus of the Ontario Ministry of Natural Resources. Between May and November the two boats will work together in eight 17 day cruises. Five of these will be synoptic on a lakewide basis and three, fixed station vertical samplings. There are seven sampling transects which run from shore to the abyss of the lake (see Figure 16), each of which has eight stations. Bottom trawls and graded mesh gillnet gangs are the standard sampling tools for the synoptic work, and floating gillnets and a pelagic trawl are added for the vertical series.

These vessels are also responsible for supporting the major study of the benthic fauna, and will make collections at various stations by means of an epibenthic sled.

Figure 15. R.V. Kaho of the U.S. Bureau of Sport Fisheries and Wildlife (65 ft. LOA) with the smaller R.V. Namaycush (43 ft. LOA) of the Ontario Ministry of Natural Resources in the background. (Picture by Captain McIntosh).

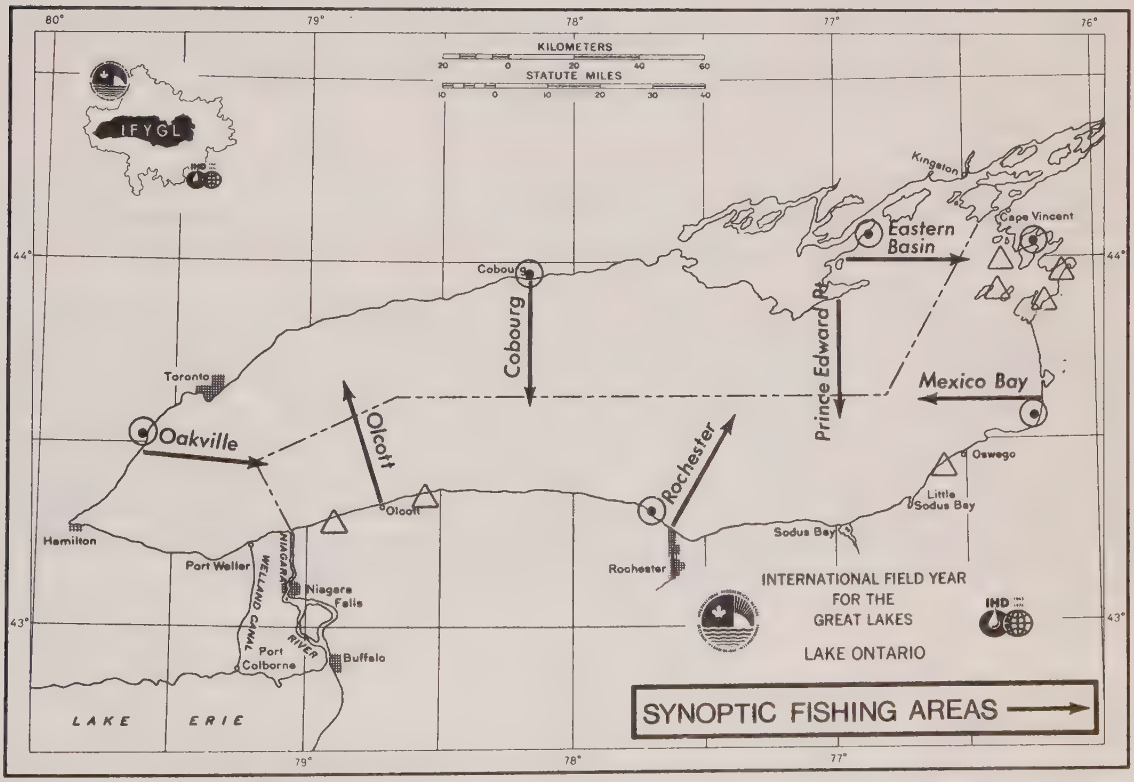

Figure 16. The approximate location of the seven synoptic fishing areas. Where practical, stations will be located at depths of 9, 18, 27, 37, 55, 91 and 146 m, plus additional stations in the deeper waters. ⊙ primary shore stations; ▲ secondary shore stations.

The inshore program is more diversified, in keeping with the broader range of fish species found in the nearshore areas. The vessel Namaycush of OMNR and R. V. Musky II of U.S. Bureau Sport Fisheries and Wildlife (Sandusky) are engaged in intensive localized work in the Bay of Quinte, and the island area of the eastern outlet basin, respectively. As with the offshore studies these boats use gillnets and trawls, but both programs will also include invertebrate sampling and the Namaycush program includes primary productivity studies in cooperation with the Canada Centre for Inland Waters. There are three primary fixed shore stations on the U.S. side occupied by USBSFW, NYDEC, and EPA, and three on the Canadian side tended by OMNR staff (see Figure 16). Sampling at these locations is carried out by seine, gillnets and trapnets. The Ontario vessel Keenosay from Lake Erie has a roving mandate to seek gaps in the species coverage, especially by inshore pelagic trawling. Another Ontario team in the Bay of Quinte will operate trapnets and seines and carry out fish tagging. Crews from the Royal Ontario Museum in Toronto, and from the National Museum in Ottawa will extend the shoreline coverage on the north side by seining, and will undertake a larval fish sampling program. On the U.S. side the gaps will be filled by the seven secondary shore stations shown in Figure 16 undertaking beach seining.

While most of the fish taken will be used for studies of age, growth, maturity, and feeding habits, many will be diverted for other studies. Samples will be submitted regularly by all collecting agencies for analysis of pesticide and heavy metal residues. The Ontario group will mount a special survey of fish parasites. The Royal Ontario Museum has been designated repository for type specimens on the Canadian side and many fish will be used for this purpose.

In a related project, the Canadian Wildlife Service is undertaking a study of pesticide residues in fish-eating birds, and it is expected that the autopsies will yield much useful information on the feeding habits.

Standard methods for the fish sampling have been agreed upon by the principal agencies. For the open lake work, data are pooled and handled through the Ann Arbor data processing facilities. Gear specifications are the same with respect to inshore and offshore gillnets and for offshore trawls and beach seines. Some trawling intercomparisons were undertaken in 1971 in preparation for the offshore work. Vessel power was badly mis-matched, but the crews put much effort into standardizing horizontal distance, towing speed, and net rigging, and sufficient progress was made to give confidence that identical fishing efficiencies can be expected during 1972.

RESULTS FROM AN INTERCOMPARISON OF MEASUREMENT FROM DEEP WATER LAKE BUOY SYSTEMS

Recognised at an early stage in the planning for IFYGL was the need for field intercomparison of the different measuring systems that were designed to measure the same things. This report describes the results of an intercomparison of the meteorological and limnological data obtained from the moorings to be used by NOAA and CCIW in the deep water lake buoy network.

Description of Systems

The two systems shown schematically in Figures 1, 2 and 17, and are described in detail in the IFYGL Technical Plan, Vol. 2. The CCIW system, which is actually two moorings, one limnological and the other meteorological, has developed over several years of testing and experimentation. The NOAA system was designed to meet specifications established for the IFYGL program and, at the time of the intercomparison test, was essentially unproven as a complete package. This fact made intercomparison more desirable. Table 1 summarizes the sensors included in the two systems.

Table 1. Sensors for the Canadian and U.S. deep-water buoys

Parameter		Transducers	
		Canadian	U.S.
Air Temperature		Thermistor	Thermistor
Relative Humidity		Lithium chloride resistor	------
Dew Point Temperature		--------	Dew Cell
Wind Speed		Cup	Cup
Wind Direction		Vane	Vane
Air Pressure		Aneroid cell	Aneroid cell
Water Temperature	Surface	Thermistor *	--------
" "	15m	Thermistor in current meter *	--------
" "	Profile	Thermistor *	Thermistor
Current Velocity		Plessey DC-6 Geodyne Model 920	 Bendix Marine Advisors Q-15

* Thermistor chains on separate buoys, 15 m temperature with the current meter, surface temperature on the meteorological buoy. U.S. surface temperature will be part of the profile on the NOAA buoys in 1972.

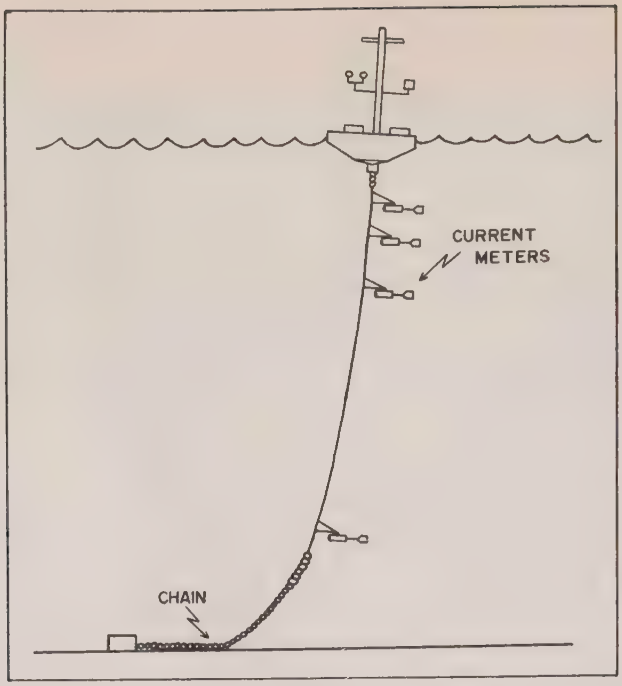

Figure 17. U.S. mooring system for deep water buoys.

Among the differences between the systems, the mooring type is important. The CCIW meteorological mooring is a slack-wire type, while the limnological mooring is of the taut-wire kind, with a subsurface float at about 8 m depth. The NOAA system is also a taut-wire moor, but has a surface float.

Another difference, important in the interpretation of data from the systems, is that the NOAA system is telemetering whereas the CCIW system is internally recording. The realtime capability of the NOAA system is advantageous for data verification and planning of system servicing. The main disadvantage of the NOAA system is that it transmits instantaneous observations from all sensors. The vector quantities (wind and current) and solar radiation are therefore not integrated for significant periods and include a large natural variance component. The CCIW system integrates wind speed, solar radiation, and current speed (Plessey meter) for 10 minute periods prior to recording.

Intercomparison Procedures

The intercomparison was carried out in the period September-November 1971. The site of the test was near where deep water buoy number 16 will be located during IFYGL. Figure 18 shows the deployed pattern of test moorings. Initially the "prototype" NOAA buoy was anchored at 43°23'54"N, 77°31'12"W in 157 m depth. This buoy was labelled NOAA-15 prior to November 1, and NOAA-17 thereafter, following a change of some of the sensors. The two other U.S.

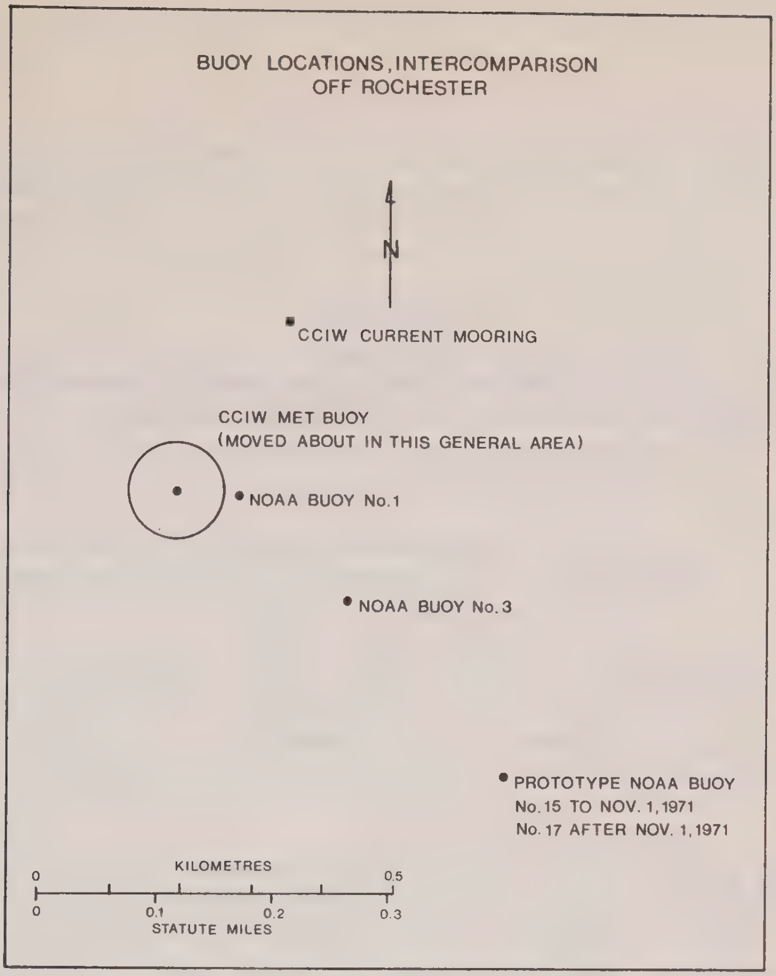

Figure 18. Relative buoy positions during deep water lake meter intercomparison trials.

buoys were labelled NOAA-1 and NOAA-3. The CCIW meteorological buoy was anchored about 100 m to the west of NOAA-1, while the CCIW limnological mooring was 250 m north of NOAA-1, and 700 m northwest of NOAA-15 (17).

The test procedures called for deployment of the buoys for a significantly long period of simultaneous measurement, independent reduction of the data, and comparison using appropriate statistics. The test began in September, but the first testing period (September 8 to October 6) produced essentially no results worthy of comparison. The CCIW buoys were deployed for the period October 13 to November 9. Much of the NOAA meteorological data from this period is usuable, but good current meter data was obtained only during the period 1-4 November.

Test Results

General

In this report, emphasis is placed on data obtained during the period 29 October through 4 November. These data are sufficient to provide initial estimates of how well the two systems measure the same environmental parameters. Fortunately, large changes occurred in all measured variables during this period.

An unexpected problem arose in assigning of exact or absolute times to the series of NOAA and CCIW observations. The data indicated that the clocks may have deviated by as much as 30 minutes between systems. It is not known which clock was the most accurate.

Table 2. Summary of meteorological buoy intercomparisons. Data are in differences of CCIW-NOAA values. All values are hourly averages.

BUOY	NOAA-3	NOAA-15	NOAA-1	NOAA-17
Air Temperature Range 9.6 to 16.7 °C				
Mean Differences (°C)	-0.13	0.20	-0.14	0.14
S.D. Differences (°C)	0.97	0.90	0.71	0.15
No. Hours	28	29	47	16
Dew Point Temperature Range 2.2. to 14.2 °C				
Mean Differences (°C)	-1.33	-1.27	-1.00	-0.68
S.D. Differences (°C)	0.77	1.46	0.99	0.29
No. Hours	28	27	47	16
Wind Speed Range 0.3 to 12.3 m/s				
Mean Differences (m/s)	1.78	0.18	0.15	0.15
S.D. Differences (m/s)	1.54	1.49	1.22	0.67
No. Hours	28	28	47	16
Wind Direction *				
Mean Difference (deg)	2.65	13.2	11.4	-2.2
S.D. Differences (deg)	53.9	48.2	39.2	22.6
No. Hours	28	29	47	16

* Large wind direction differences occur at wind speeds less than 5 m/s.

Hourly averages, used to make the intercomparisons, were chosen for several reasons. First, the CCIW data were obtained at 10 minute intervals, while the NOAA system was sampled every 6 minutes. Secondly, some of the CCIW sensor output is integrated over the 10 minute intervals, while NOAA data are all instantaneous readings. Thirdly, absolute timing of the observations was not certain closer than 30 minutes between systems.

Meteorological

For the testing of meteorological sensors, data from three NOAA buoys were compared with those from the one CCIW buoy obtained during the period 22 October to 3 November. Hourly averages of air temperature, dew point temperature, wind speed, and wind direction were compared. The results are summarized in Table 2, which shows for each parameter and NOAA buoy the mean difference, and standard deviation of the difference from the CCIW value, and the number of hourly averages available for intercomparison.

The relatively small differences shown in Table 2 for air temperature indicate small or insignificant biases.

NOAA wind speeds were consistently lower than CCIW values, but by less than 0.2 m/s, except in the case of NOAA-3 which on the average recorded speeds lower by 1.8 m/s. The mean difference for wind direction was largest for this buoy also, suggesting that the anemometer was defective or not aligning itself properly. The other measures of wind direction appear to be reasonably consistent.

A definite bias in dew point temperature exists between the systems with the NOAA values consistently higher than CCIW values. The CCIW system responds to relative humidity, while the NOAA system reads dew point temperature directly. The NOAA values were sometimes higher than the corresponding hourly average values of air temperature, indicating possible error in calibration

Limnological

Water current and temperature measurements made during the period 1-4 November at 14 m depth were used for intercomparison. The CCIW values were sensed and recorded by a Geodyne Model 920-3 instrument; NOAA-17, located 700 m from the CCIW mooring, was the only U.S. buoy having a working Q-15 current meter at that time. NOAA temperature data were available from all buoys. A summary of data comparisons is given in Table 3.

The temperature means determined by the two systems are very close; in particular, the results from three NOAA buoys are highly consistent. The agreement appears to be good between the two systems in measuring the water temperature.

CCIW current speed values were quite consistently higher than NOAA values. About two-thirds of the mean difference of 6.1 cm/s is accounted for by a starting speed correction which is not included in the NOAA data; the rest of the difference may be due to the effect of mooring motion on the CCIW data, or to a need for further calibrations.

Table 3. Summary of limnological data from the intercomparison tests. Data are CCIW hourly values less hourly values from indicated NOAA buoys.

	NOAA-17	NOAA-15	NOAA-1	NOAA-3
Current Speed (observed range: 0.0 to 48.0 cm/s)				
Mean Difference (cm/s)	6.1			
Mean |Difference| (cm/s)	6.6			
Number hours	28			
Current Direction				
Mean Difference (deg)	-10.4			
Mean |Difference| (deg)	40.2			
Number hours	28			
Temperature (observed range 6.7 to 15.2 °C)				
Mean Difference (°C)	-0.03	0.22	0.18	0.19
Mean |Difference| (°C)	0.22	0.69	--	--
Number hours	19	25	25	25

The current direction data show a very high scatter in the difference between systems, but the mean difference is relatively small, with the NOAA direction being about 10 degrees higher (to the right of) than the CCIW direction. This mean difference and the variability of the differences is apparently not related to the timing error between systems.

Conclusion

The intercomparison program was a partial success. However, enough data were obtained for a meaningful comparison of sensors. The results are generally encouraging, especially in the case of the meteorological sensors.

Recommendations

(a) Intercomparison periods should continue throughout the IFYGL similar to that described here. Care should be taken to eliminate spatial and timing errors; *in situ* reference tests with recently calibrated sensors should be part of the intercomparison.

(b) In view of the many kinds of relatively simple problems which can lead to data uncertainty in the deep-water program, *in situ* checks of all buoy systems should be made wherever and whenever possible.

NOTES FROM THE CANADIAN COORDINATOR'S DIARY

Ships

Fifteen cruise reports have been filed at the IFYGL Centre reporting successful missions of MV Martin Karlsen, CSS Limnos, MV Lac Erie, and CCGS Porte Dauphine. Eleven of the twelve Decca marker buoys were anchored in about 20 m of water round the periphery of the lake by MV Martin Karlsen on 13 to 16 March 1972; ice conditions delayed the installation of the twelfth which is now in the eastern outlet basin. The eleven meteorological buoys were placed by two ships slightly ahead of schedule between 21 and 28 March; all stations were instrumented by 25 April 1972. In addition to the routine observations a live zooplankton sample was obtained from station 3 (43° 25'N, 79° 17'W) where the lake is 117 m deep. The first lake-wide heat content and eutrophication cruise was successfully accomplished between 4 and 7 April, by CSS Limnos and CCGS Porte Dauphine. Slight changes in the cruise plans were occasioned by strong winds, ice, and 3 m high waves. Four complete heat content and surface eutrophication surveys were completed by 26 April 1972; the lake was colder than previously observed by CCIW. The first of nine Ontario Organic Particle Study (OOPS) cruises was undertaken, according to plan, in the period 10 to 22 April; calm weather allowed extensive use of the whaler, permitting simultaneous tending of the in situ moorings and shipboard sampling. Lake water specific conductance was about 10% lower than observed in 1971 at the same time of year. The Decca position fixing chain was calibrated, the signal strength was measured, and the Decca buoys were picked up by radar from a range of 6 km. The USBSF & W ship Kaho was operating out of CCIW and participating in the cooperative fish program.

Aircraft

The Atmospheric Environment Service commenced its IFYGL program of lake-wide remote sensing of water surface temperature, on 5 January, 1972 with a successful flight over the western, fog-free half of the lake. To date the results of twenty flights have been distributed to an extensive mailing list. Flights took place on the following dates where the brackets indicate that only the western half was observed: (5), 10, 18, 27 and (31) January; 2, (11), 16, 21 and 28 February; 6, 13, 20, and 27 March; (7), (11), 12, 17, and 25 April; and 1 May 1972. On 1 May, the near shore water temperature ranged between 4 and 9 $^{\circ}$C.

Towers

The micrometeorological site, off Niagara-on-the-Lake, was installed and staff from AES and CCIW were commissioning their equipment. Intercomparisons with the United States aircraft measurements were planned for the week 8 to 12 May 1972.

Recent Papers and Reports of interest to IFYGL Participants

Csanady, G. T. 1971a. Coastal Entrapment in Lake Huron. In Advances in Water Pollution Research, edited by S. H. Jenkins, Vol. 2, p. III-11.

Csanady, G. T. 1971b. Turbulent diffusion in The Great Lakes; Some fundamental aspects. Unpublished.

Csanady, G. T. 1971c. On the equilibrium shape of the thermocline in a shore zone. Journal of Physical Oceanography, 1, 263.

Csanady, G. T. 1972. The coastal boundary layer in Lake Ontario, Part I: The Spring regime. Journal of Physical Oceanography, 2, 41.

Robinson, P.J., Davies, J.A., and Nunez, M. 1972. Longwave radiation exchanges over Lake Ontario. Report No. 4 prepared by McMaster University for Department of the Environment, Canada Centre for Inland Waters, Burlington, Ontario.

Erratum

IFYGL Bulletin 2, page 17. Figures 5 and 6 should be interchanged to agree with captions.

Meteorological Buoy Locations

Final positions of Canadian network of lake wide limno-meteorological buoys, as established by means of IFYGL Decca position fixing system.

IFYGL number	Water depth (m)	Latitude North			Longitude West		
		deg.	min.	sec.	deg.	min.	sec.
1	92	43	25	34	79	30	51
2	108	43	30	53	79	19	01
3	117	43	24	23	79	17	20
4	14	43	17	31	79	07	55
13	129	43	20	58	78	38	41
6	83	43	43	56	78	49	23
7	143	43	38	48	78	29	30
8	63	43	57	19	77	56	13
9	68	43	51	10	77	41	09
10	138	43	39	20	77	42	20
11	74	43	47	28	76	50	31

5 May 1972

UNITED STATES

COMMENTS BY THE U.S. DIRECTOR

In IFYGL Bulletin No. 1 we presented the status of the U.S. part of the IFYGL program as of November 1, 1971. This issue reports on the progress of plans and developments up to the beginning of the field operations, April 1, 1972. A slightly revised gross schedule for U.S. activities is shown in figure 1, the vertical broken lines indicating the 4-month period covered by this Bulletin.

During this 4-month interval, a major accomplishment was the completion of the IFYGL Technical Plan. Decision on issuing the plan, which represents the culmination of many years of United States and Canadian planning efforts, was reached last November by the Joint Management Team. A subsequent draft of the plan was reviewed at the Washington Workshop in January of this year, with contributions made by all participants. Consisting of four volumes (Volume 1 - Scientific Plan; Volume 2 - Data Acquisition Systems; Volume 3 - Field Operations Plan; Volume 4 - Data Management Plan), this document will undoubtedly contribute to a successful program by identifying the interdependent time-phased activities of the more than 600 participating scientists, engineers, and technicians. The plan will be updated as required to fill voids and eliminate errors and deficiencies, and will, it is hoped, reflect on a continuing basis developments occurring during the Field Year.

As of March 31, the U.S. program was essentially on schedule. The Oswego and Buffalo radars and the Rochester precipitation network were ready to begin measurements on that date. Because of both technical and natural contingencies, such as ice in the St. Lawrence Seaway, some uncertainty exists concerning our ability to adhere strictly to the schedule for other engineering, test, and data system comparisons activities shown in figure 1, but every effort is being made to ensure smooth operation of all systems.

Highlights of other developments, some of which are discussed in greater detail in other sections of this Bulletin, are:

- Opening of the U.S. Field Headquarters in Rochester, N.Y.
- Establishment of the EPA Water Chemistry Laboratory at the University of Rochester.
- Considerable progress in the chemistry and biology program plans.
- Coordination with the U.S. Project Office of several potential remote sensing projects by the NASA Earth Resources Satellite Program.
- Definition of, and designation of responsibility for, 69 individual IFYGL tasks.

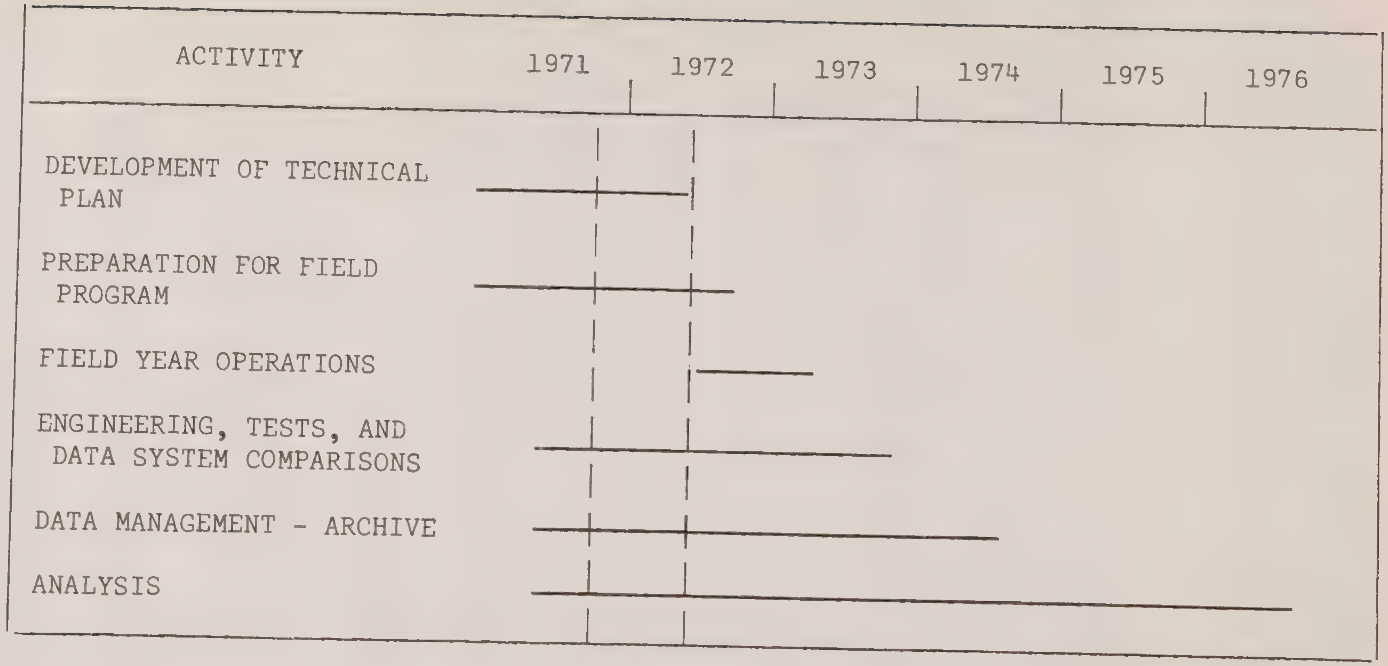

Figure 1. U.S. IFYGL gross schedule.

- Establishment of a Field Data Center at the U.S. Field Headquarters.

- Agreement by the National Oceanographic Instrumentation Center, NOAA, to assist the Project Office in initial calibration of oceanographic and meteorological sensors for the ships and the Texas Instruments data acquisition system and in the establishment of a calibration facility at the Field Headquarters.

- Encouraging results of United States and Canadian buoy intercomparison tests in 1971.

- Scheduling of an intercomparison of oceanographic and surface meteorological sensors, at the suggestion of Canada through the Joint Management Team, at buoy site No. 13 off Olcott, N.Y., beginning as early in May as systems become operational

- Suggestion to be submitted as a recommendation to Canada via the Joint Management Team for intercomparison of lake-scale ship measurements of physical, chemical, and biological parameters.

- Progress in formulating plans for a synthesis program to serve water resources management needs by using IFYGL data in developing better methods for evaluating the environmental impacts of management alternatives.

Future issues of the IFYGL Bulletin will continue to serve as an informal means for exchange of information among the IFYGL participants, as well as others interested in the progress and activities of the Field Year. Contributions for this issue were sought from only 18 of the U.S. participants; in succeeding issues reports on developments will be solicited from all U.S. project scientists.

U.S. SCIENTIFIC PROGRAM

This section identifies the 69 individual IFYGL tasks for which the United States has either full responsibility or shares responsibility with Canadian participants. The names and affiliations of the principal investigators are given, and the objective of each task briefly summarized. Discussed also in this section are developments in some of the various program areas that were outlined in IFYGL Bulletin No. 1. An attempt is also made to graphically show the interrelationships among the specific tasks, the program areas, and user needs in terms of water resource management.

Task Descriptions

Given below is a complete listing of all U.S. IFYGL Tasks arranged alphabetically by the names of the principal investigators. In cases of joint responsibility, the names of both the United States and Canadian principal investigators are given. Italicized numbers in parentheses refer to page numbers in IFYGL Technical Plan, Volume I, Scientific Program.

1. Title: *Phosphorus Release and Uptake by Lake Ontario Sediments*

   Principal Investigator: *D.E. Armstrong,* Water Chemistry Program, University of Wisconsin, Madison, Wisconsin 53706, Tel: (608) 262-2470.

   Objective: Determining the amount and the forms of phosphate in the sediment of Lake Ontario, the relative mobility within different sediments and sedimentary environments, and the phosphorus balance between sediments and the lake waters at the sediment water interface. *(245)*

2. Title: *Net Radiation*

   Principal Investigator: *M.A. Atwater,* The Center for the Environment and Man, Inc., 275 Windsor Street, Hartford, Connecticut 06120, Tel: (203) 549-4400.

   Objective: Accurate computation of the net radiation flux across the surface of Lake Ontario. *(179)*

3. Title: *RFF/DC-6 Boundary Layer Fluxes*

   Principal Investigator: *B.R. Bean,* Wave Propagation Laboratory, NOAA, Boulder, Colorado 80302, Tel: (303) 447-6257.

   Objective: Airborne determination of the fluxes of water vapor, heat, and momentum. *(413)*

4. Title: *Nitrogen Fixation*

Principal Investigator: *R. Burris,* Department of Biochemistry, University of Wisconsin, Madison, Wisconsin 53706, Tel: (608) 262-3042.

Objective: Furthering understanding of the relationship of nutrients and algae through measurements of nitrogen fixation by blue-green algae.

5. Title: *Mentor Buoy and Tower Program*

Principal Investigator: *J.A. Businger,* Department of Atmospheric Sciences, University of Washington, Seattle, Washington 98105, Tel: (206) 543-4595.

Objective: Study of air-mass modification and internal boundary layer formation as the cold air from the land passes over the relatively warm lake. *(418)*

6. Title: *Status of Lake Ontario Fish Populations*

Principal Investigator: *J.F. Carr,* Great Lakes Fishery Laboratory, Bureau of Sport Fisheries and Wildlife, 1451 Green Road, P.O. Box 640, Ann Arbor, Michigan 48107, Tel: (313) 769-7100.

Objective: Determining for Lake Ontario fish stocks the species composition, distribution, relative abundance, growth rates, and incidence of lamprey predation; determining the major food pathways (materials transfer) among fish populations; and evaluating influence of environmental factors on the distribution of Lake Ontario fish stocks through correlation with other pertinent IFYGL data. *(295)*

7. Title: *Material Balance of Lake Ontario*

Principal Investigator: *D.J. Casey,* Rochester Field Station, Environmental Protection Agency, University of Rochester, Rochester, New York 14612, Tel: (716) 275-4513.

Objective: Determining the amount and form of materials entering, leaving, and residing in Lake Ontario, with emphasis on basic plant nutrients and, to a lesser extent, on heavy metals. *(236)*

8. Title: *Runoff*

Principal Investigator: *B.G. DeCooke,* U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6440.

Objective: Determining total runoff from basin into Lake Ontario for selected periods. *(72)*

9. Title: *Evaporation (Lake - Land)*

Principal Investigators: *B.G. DeCooke,* U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6440; and *D.F. Witherspoon,* Great Lakes - St. Lawrence Study Office, Environment Canada, 318 Federal Building, Cornwall, Ontario, Tel: (613) 932-4325.

Objective: Computing the evaporation from the lake and land based on data gathered by other principal investigators in the Terrestrial Water Balance program, by the Meteorological Service of Canada, and by the National Weather Service, NOAA. *(76)*

10. Title: *Simulation Studies and Analyses Associated with the Terrestrial Water Balance*

Principal Investigators: *B.G. DeCooke,* U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6440; and *D.F. Witherspoon,* Great Lakes - St. Lawrence Study Office, Environment Canada, 318 Federal Building, Cornwall, Ontario, Tel: (613) 932-4325.

Objective: Analysis of all data used in computing the weekly and monthly evaporation values and the determination of the statistical significance of each of the variables affecting the water balance relationship. *(80)*

11. Title: *Land Precipitation Data Analysis*

Principal Investigators: *B.G. DeCooke* and *E. Megerian,* U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6440.

Objective: Determining a land precipitation value for the U.S. side of the Lake Ontario Basin for selected periods. *(42)*

12. Title: *Transport Processes Within the Rochester Embayment of Lake Ontario*

Principal Investigator: *W.H. Diment,* Department of Geological Sciences, University of Rochester, Rochester, New York 14627, Tel: (716) 275-2410.

Objective: Developing a basis for predicting the quality of water within the embayment as a function of time and position from a knowledge of season and wind history; and study of the impact of a near-shore zone of Lake Ontario. *(294)*

13. Title: *Soil Moisture and Snow Hydrology*

Principal Investigator: *W. Embree,* U.S. Geological Survey, P.O. Box 948, Albany, New York 12201, Tel: (518) 472-3107.

Objective: Obtaining best estimate of the changes in the quantity of water stored in the unsaturated zone, and obtaining data to better define the contribution of snow melt to soil moisture. *(51)*

14. Title: *Boundary Layer Structure and Mesoscale Circulation*

Principal Investigator: *M.A. Estoque,* School of Marine and Atmospheric Sciences, University of Miami, P.O. Box 9115, Coral Gables, Florida 33124, Tel: (305) 284-2335.

Objective: Determining the structure and behavior of mesoscale disturbances produced by Lake Ontario. *(425)*

15. Title: *Mesoscale Simulation Studies*

Principal Investigator: *M.A. Estoque,* School of Marine and Atmospheric Sciences, University of Miami, P.O. Box 9115, Coral Gables, Florida 33124, Tel: (305) 284-2335.

Objective: Construction of theoretical models of two types of mesoscale phenomena produced by Lake Ontario.

16. Title: *Lake Level Transfer Across Large Lake*

Principal Investigators: *C.B. Feldscher,* NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6118; and *G.C. Dohler,* Tides and Water Levels, Department of the Environment, 615 Booth Street, Ottawa, Ontario, KIA OE4, Tel: (613) 994-9122.

Objective: Evaluating the effects of wind, differentials in barometric pressure, tides, and water and air temperatures on the tilt or warp of the lake surface. *(89)*

17. Title: *Near-Shore Ice Formation, Growth, and Decay*

Principal Investigator: *L.M. Gilbert,* General Electric Company, Valley Forge Space Center, P.O. Box 8555, Philadelphia, Pennsylvania 19101, Tel: (215) 962-3998.

Objective: Design, fabrication, and deployment of a system for gathering information on temperature fluxes at the land/air, air/water, and sediment/water interfaces on Lake Ontario, and development of a model for predicting ice formation, growth, and decay based on information on heat transfer at these interfaces.

18. Title: *Advection Term - Energy Balance*

Principal Investigator: *J.L. Grumblatt,* NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6123.

Objective: Developing the advection term in the general heat budget equation, with intensive measurement periods to coincide with the Terrestrial Water Balance program. *(176)*

19. Title: *Occurrence and Transport of Nutrients and Hazardous Polluting Substances in the Genesee River Basin*

Principal Investigator: *L.J. Hetling,* Director, Environmental Quality Research, New York State Department of Environmental Conservation, 50 Wolf Road, Albany, New York 12201, Tel: (518) 457-7470.

Objective: Investigating the sources and rates of discharge of various hazardous polluting substances and nutrients in the Genesee River Basin and determining the history of these pollutants in terms of the rate of transportation, storage, and decay within the streams. *(243)*

20. Title: *Boundary Layer Flux Synthesis*

Principal Investigator: *J.Z. Holland,* Director, Center for Experiment Design and Data Analysis (Rx8), NOAA, Rockville, Maryland 20852, Tel: (301) 496-8871.

Objective: Development, from IFYGL tower, aircraft, buoy, captive balloon, indirect sensor and surface data, of best estimates of vertical eddy fluxes of sensible and latent heat, water vapor, and momentum in the atmospheric surface layer over Lake Ontario. *(428)*

21. Title: *Hazardous Material Flow*

Principal Investigators: *N.A. Jaworski (Coordinator),* Office of Research and Monitoring, Environmental Protection Agency, Grosse Ile Laboratory, Grosse Ile, Michigan 48138, Tel: (313) 675-5000; *R.L. Booth (Organic Materials),* Analytical Quality Control Laboratory, Office of Research and Monitoring, Environmental Protection Agency, Cincinnati, Ohio 45268;

D.J. Casey (Routine Metals), Rochester Field Station, Environmental Protection Agency, Region II, University of Rochester, Rochester, New York 14612; *W.T. Donaldson (Specific Metals)*, Southeast Water Laboratory, Office of Research and Monitoring, Environmental Protection Agency, Athens, Georgia 30601; *R.B. Moore (Pesticides)*, Lake Ontario Environmental Laboratory, State University College, Oswego, New York 13126; and *R.J. Velten (Radioactive Materials)*, Office of Operations, Environmental Protection Agency, 5555 Ridge Avenue, Cincinnati, Ohio 45268.

Objective: Attempt to determine the amount of hazardous materials entering, leaving, and residing within Lake Ontario, and the distribution of hazardous materials in the various trophic levels and in the various media. *(247)*

22. Title: *Remote Measurement of Chlorophyll with Lidar Fluorescent System*

Principal Investigator: *H.H. Kim*, Applied Science Division, Wallops Island Station, National Aeronautics and Space Administration, Wallops Island, Virginia 23337, Tel: (708) 824-3411 x 653.
Objective:
Objective: Field testing and evaluation of a Lidar Fluorescent System for remote measurement of chlorophyll concentration. *(263)*

23. Title: *Inflow/Outflow Term - Terrestrial Water Budget*

Principal Investigator: *I.M. Korkigian*, U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6751.

Objective: Determining, by various measurement techniques, the inflow to Lake Ontario from the Niagara River and the Welland Canal, and the outflow from the lake through the St. Lawrence River. *(26)*

24. Title: *Use of an Unsteady-State Flow Model to Compute Continuous Flow*

Principal Investigator: *I.M. Korkigian*, U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6751.

Objective: Developing a mathematical model of unsteady-state flow for the purpose of computing continuous flow. *(83)*

25. Title: *Radiant Power, Temperature, and Water Vapor Profiles Over Lake Ontario*

Principal Investigator: *P.M. Kuhn,* Atmospheric Physics and Chemistry Laboratory, NOAA Environmental Research Laboratories, Boulder, Colorado 80302, Tel: (303) 447-6208.

Objective: Obtaining the total and infrared vertical profiles of upward, downward, and net radiation and the atmospheric radiation cooling. Determining the vertical lapse of temperature and water vapor in the free atmosphere. *(187)*

26. Title: *Algal Nutrient Availability and Limitation on Lake Ontario*

Principal Investigator: *G.F. Lee,* Water Chemistry Program, University of Wisconsin, Madison, Wisconsin 53706, Tel: (608) 262-2470.

Objective: Defining the sources and availability of nutrients and what nutrient is rate limiting or can be made rate limiting. *(268)*

27. Title: *Wave Studies*

Principal Investigator: *P.C. Liu,* NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6048.

Objective: Providing unique information with which to correlate the available theoretical models of wind-wave generation and their applicability to Great Lakes waves. *(357)*

28. Title: *Cloud Climatology*

Principal Investigator: *W.A. Lyons,* Department of Geography and Center for Great Lakes Studies, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201, Tel: (414) 228-4875.

Objective: Developing a mesoscale climatology of insolation and clouds over Lake Ontario and surrounding areas. *(182)*

29. Title: *Zooplankton Production in Lake Ontario as Influenced by Environmental Perturbations*

Principal Investigator: *D.C. McNaught,* Department of Biological Science, State University of New York at Albany, Albany, New York 12203, Tel: (518) 459-8895.

Objective: Lake-wide description of the seasonal zooplankton production for Lake Ontario, including taxonomic description of the population and the total biomass present. *(271)*

30. Title: *Change in Lake Storage Term - Terrestrial Water Budget*

Principal Investigator: *E. Megerian,* U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6441.

Objective: Determining the effect of gage location on water level readings and storage determinations, and producing the gage network that will best represent the change in storage between selected periods. *(36)*

31. Title: *Soil Moisture*

Principal Investigator: *E. Megerian,* U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6441.

Objective: Determining soil moisture for the U.S. side of the Lake Ontario Basin. *(54)*

32. Title: *Testing of COE (Corps of Engineers) Lake Levels Model*

Principal Investigator: *E. Megerian,* U.S. Army Corps of Engineers, Detroit District, 150 Michigan Avenue, Detroit, Michigan 48226, Tel: (313) 226-6441.

Objective: Developing a lake levels model that will reflect the still water level of the lake. *(86)*

33. Title: *Near-Shore Study of Eastern Lake Ontario*

Principal Investigator: *R.B. Moore,* Lake Ontario Environmental Laboratory, State University College, Oswego, New York 13126, Tel: (315) 341-3088.

Objective: Gathering basic information on the changes in chemistry, biology, and, to some extent, the physical environment through the Field Year. *(290)*

34. Title: *Internal Waves - Transects Program - Interpretation of Whole-Basin Oscillations*

Principal Investigator: *C.H. Mortimer,* Director, Center for Great Lakes Studies, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201, Tel: (608) 963-4196.

Objective: Measuring and analyzing variations in temperature distributions in two Lake Ontario cross sections to contribute to the understanding of the structure and mode of generation of upwelling and dominant internal wave patterns. *(349)*

35. Title: *Pontoporeia affinis and Other Benthos in Lake Ontario*

Principal Investigator: *S.C. Mosley,* Great Lakes Research Division, University of Michigan, Ann Arbor, Michigan 48104, Tel: (313) 764-2420.

Objective: Documenting seasonal and regional differences among populations of *Pontoporeia affinis,* an important fish forage organism, and relating them to environmental differences. *(276)*

36. Title: *Pan Evaporation Project*

Principal Investigators: *T.J. Nordenson,* Acting Director, Hydrologic Research and Development Laboratory (W23), NOAA, Silver Spring, Maryland 20910, Tel: (301) 495-2246; and *J.A.W. McCulloch,* Department of the Environment, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario, Tel: (416) 635-4618.

Objective: Installation and operation of evaporation pan stations around Lake Ontario to provide data for computing daily "shallow" lake evaporation by four essentially independent techniques. *(101)*

37. Title: *Simulation Studies and Other Analyses Associated With U.S. Water Movements Projects*

Principal Investigators: *J.P. Pandolfo* and *C.A. Jacobs,* The Center for the Environment and Man, 275 Windsor Street, Hartford, Connecticut 06120, Tel: (203) 549-4400.

Objectives: Modifying an existing three-dimensional air-sea interaction model to simulate the three-dimensional circulation in an enclosed body of water of variable depth, simulating some typical dynamic conditions for Lake Ontario, and validating the model. *(361)*

38. Title: *Tower Program*

Principal Investigator: *H.A. Panofsky,* Department of Meteorology, Pennsylvania State University, University Park, Pennsylvania 16802, Tel: (814) 865-0478.

Objective: Comparison of coherence of wind fluctuations with horizontal or vertical separation over a lake with corresponding statistics over land. *(411)*

39. Title: *Airborne Snow Reconnaissance*

Principal Investigator: *E. Peck*, Chief, Research Branch, Hydrologic Research and Development Laboratory (W232), NOAA, Silver Spring, Maryland 20910, Tel: (301) 495-2248.

Objective: Combined application of ground and airborne survey data of terrestrial gamma radiation to obtain water equivalent profiles and mean water equivalents along selected flight lines. *(58)*

40. Title: *Optical Properties of Lake Ontario*

Principal Investigator: *K.R. Piech*, Cornell Aeronautical Laboratory, Inc., P.O. Box 235, Buffalo, New York 14221, Tel: (716) 632-7500.

Objective: Assessing the significant optical properties of Lake Ontario as they relate to various geophysical and ecological lake characteristics. *(202)*

41. Title: *Storage Term - Energy Balance Program*

Principal Investigator: *A.P. Pinsak*, NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6309.

Objective: Testing and correlating various methods used to measure and estimate lake heat storage and applying these to the computation of the energy budget of Lake Ontario. *(168)*

42. Title: *Sensible and Latent Heat Flux*

Principal Investigator: *A.P. Pinsak*, NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6309.

Objective: Based on measured detailed profiles of sensible heat flux or evaporation across the air-water interface, checking the use of the Bowen Ratio in obtaining the sensible heat transfer and evaporative heat loss terms in the general energy budget equation; developing improved methods for parameterization of these terms. *(196)*

43. Title: *Thermal Characteristics of Lake Ontario and Advection Within the Lake*

Principal Investigator: *A.P. Pinsak*, NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6309.

Objective: Analysis of the time-spatial variations in thermal structure within Lake Ontario and correlation with forces acting on and within the lake, leading to definition of the natural distribution and variability of heat within the lake. *(198)*

44. Title: *Oswego Harbor Studies*

Principal Investigator: *A.P. Pinsak,* NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6309.

Objective: Investigating the critical water quality parameters in Oswego Harbor and in the area of diffusion in the adjacent portion of Lake Ontario on a time-spatial basis. *(251)*

45. Title: *Mapping of Standing Water and Terrain Conditions With Remote Sensor Data*

Principal Investigator: *F.C. Polcyn,* Infrared and Optics Laboratory, University of Michigan, P.O. Box 618, Ann Arbor, Michigan 48107, Tel: (313) 483-0500.

Objective: Obtaining area and precentage of total area of standing water for representative watersheds and measuring areas and percentages of total area of various land uses for estimates useful in computation of terrestrial storage and runoff. *(62)*

46. Title: *Remote Sensing Program for the Determination of Cladophora Distribution*

Principal Investigators: *F.C. Polcyn* and *C.T. Wezernak,* Infrared and Optics Laboratory, University of Michigan, P.O. Box 618, Ann Arbor, Michigan, 48107, Tel: (313) 486-0500.

Objective: Delineating the distribution of *Cladophora* along the entire shore of Lake Ontario by use of remote sensing techniques. *(265)*

47. Title: *Remote Sensing Study of Suspended Inputs Into Lake Ontario*

Principal Investigators: *F.C. Polcyn* and *C.T. Wezernak,* Infrared and Optics Laboratory, University of Michigan, P.O. Box 618, Ann Arbor, Michigan 48107, Tel: (313) 483-0500.

Objectives: Defining the diffusion and dispersion patterns of suspended solids loads introduced into Lake Ontario by tributary rivers, and of major industrial and municipal discharges. *(333)*

48. Title: *Island - Land Precipitation Data Analysis*

Principal Investigator: *F.H. Quinn,* NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-7463.

Objective: Installation and operation of precipitation gages on and around Lake Ontario to provide data on the relationship of overwater to overland precipitation. *(40)*

49. Title: *Lake Circulation, Including Internal Waves and Storm Surges*

Principal Investigator: *D.B. Rao,* Center for Great Lakes Studies, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201, Tel: (608) 963-4196.

Objective: Use of the dynamic principles of wind action on water bodies for describing and arriving at an understanding of factors that govern certain circulation characteristics of Lake Ontario. *(364)*

50. Title: *Atmospheric Water Balance*

Principal Investigators: *E.M. Rasmusson,* Center for Experiment Design and Data Analysis (Rx8), NOAA, Rockville, Maryland 20852, Tel: (301) 496-8871; and *H.L. Ferguson,* Department of the Environment, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario, Tel: (416) 635-4610.

Objectives: Evaluating the heat and water balance of the lower and middle troposphere as a function of height and time; obtaining estimates of the average evaporation from Lake Ontario for periods of approximately 1 week; investigating the character of synoptic-scale variations in evaporation and in the heat and water balance of the atmosphere; investigating the momentum and kinetic energy budgets of the lower troposphere. *(93)*

51. Title: *Evaporation Synthesis*

Principal Investigators: *E.M. Rasmusson,* Center for Experiment Design and Data Analysis (Rx8), NOAA, Rockville, Maryland 20852, Tel: (301) 496-8871; and *T.L. Richards,* Atmospheric Environment Service, Department of the Environment, 4905 Dufferin Street, Downsview, Ontario, Tel: (416) 635-4617.

Objective: Review of evaporation estimates derived from evaluations of the lake energy balance, the terrestrial water budget, and the atmospheric water budget to derive best estimates of average evaporation for periods of from 1 to 2 weeks; calibration, based on these estimates, of the mass transfer equation for Lake Ontario and derivation of estimates of lake evaporation from shoreline evaporation pan measurements. *(433)*

52. Title: *Ground-Water Flux and Land Storage*

Principal Investigator: *E.C. Rhodehamel*, U.S. Geological Survey, P.O. Box 948, Albany, New York 12201, Tel: (518) 472-3107.

Objectives: Determining the ground-water flux (volume per unit of time) flowing directly into Lake Ontario from stream interfluxes fronting on the lake, and the changes in ground-water volume gained or lost from the overall land storage factor of the lake budget throughout the part of the Lake Ontario Basin lying in New York State. *(46)*

53. Title: *Spring Algal Blooms*

Principal Investigator: *A. Robertson*, U.S. IFYGL Project Office, NOAA, Rockville, Maryland 20852, Tel: (301) 496-8221.

Objective: Detailed determination of the changes in concentration of plant nutrients and certain related biological properties during the spring and early summer.

54. Title: *Ice Studies for Storage Term - Energy Balance*

Principal Investigator: *D.R. Rondy*, NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6125.

Objective: Providing data for the lake heat storage term, as an aid both in better understanding the role of ice and snow in this term, and in forecasting ice formation. *(173)*

55. Title: *Lagrangian Current Observations*

Principal Investigator: *J.H. Saylor*, NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6048.

Objective: Measuring Lagrangian current trajectories in Lake Ontario. *(327)*

56. Title: *Circulation of Lake Ontario*

Principal Investigator: *J.H. Saylor*, NOAA Lake Survey Center, 630 Federal Building and U.S. Courthouse, Detroit, Michigan 48226, Tel: (313) 226-6048.

Objective: Analysis of current meter measurements from the U.S. deep water buoy network for use in determining mean lake circulations. *(330)*

57. Title: *Phytoplankton Nutrient Bioassays in the Great Lakes*

Principal Investigator: *C. Schelske,* Great Lakes Research Division, University of Michigan, Ann Arbor, Michigan 48104, Tel: (313) 764-2420.

Objectives: Study of several nutrient bioassay procedures with water from Lakes Ontario, Erie, and Michigan; obtaining data that will show the effect of different levels of major nutrients on the phytoplankton standing crop and which nutrients, if any, are limiting; comparison of the algal assay procedure with experiments on natural phytoplankton populations.

58. Title: *Runoff Term of Terrestrial Water Budget*

Principal Investigator: *G.K. Schultz,* U.S. Geological Survey, P.O. Box 948, Albany, New York 12201, Tel: (518) 472-3107.

Objective: Compiling streamflow data from areas with continuous recording gages and computing the weekly flow from about 3,000 mi^2, lying principally in the Lake Ontario Plain fronting Lake Ontario, that have none, or only a limited number, of gages. *(65)*

59. Title: *Coastal Chain Program*

Principal Investigator: *J.T. Scott,* Department of Atmospheric Sciences, State University of New York at Albany, Albany, New York 12203, Tel: (518) 457-3992.

Objective: Providing near-shore velocity and temperature data and data analyses to a variety of users. *(336)*

60. Title: *Analysis of Phytoplankton Composition and Abundance*

Principal Investigator: *E.F. Stoermer,* Great Lakes Research Division, University of Michigan, North University Building, Ann Arbor, Michigan 48105, Tel: (313) 764-2420.

Objective: Determining the qualitative and quantitative characteristics of the phytoplankton assemblage of Lake Ontario and relating the assemblages to key environmental factors. *(272)*

61. Title: *Clouds, Ice, and Surface Temperatures*

Principal Investigator: *A.E. Strong,* National Environmental Satellite Service, NOAA, Suitland, Maryland 20023, Tel: (301) 440-7236.

Objective: Routine observations of clouds, ice, and surface temperatures from NOAA satellites. *(185)*

62. Title: *Analysis and Model of the Impact of Discharges From the Niagara and Genesee Rivers on Near-Shore Biology and Chemistry*

Principal Investigator: *R.A. Sweeney,* Great Lakes Laboratory, State University College, 5 Porter Avenue, Buffalo, New York 14201, Tel: (716) 862-5422.

Objective: Study of the basic trophic levels in cooperation with the main lake phytoplankton, zooplankton, and benthic organism studies programs and modeling of the near-shore processes. *(283)*

63. Title: NCAR/DRI Buffalo Program

Principal Investigator: *J.W. Telford,* Atmospheric Physics Laboratory, Desert Research Institute, University of Nevada, Reno, Nevada 89507, Tel: (702) 972-1374.

Objective: Use of the NCAR/DRI Buffalo Airborne Measurement System for systematic documentation of the modifications to the air as it moves across Lake Ontario. *(424)*

64. Title: *Mathematical Modeling of Eutrophication of Large Lakes*

Principal Investigator: *R.V. Thomann,* Civil Engineering Department, Manhattan College, Bronx, New York 10471, Tel: (212) 548-1400.

Objective: Constructing a mathematical modeling framework of the major features of eutrophication in large lakes. *(293)*

65. Title: *Cladophora Nutrient Bioassay*

Principal Investigator: *N.A. Thomas,* Grosse Ile Laboratory, Office of Research and Monitoring, Environmental Protection Agency, Grosse Ile, Michigan 48138, Tel: (313) 226-6000.

Objective: Determining what nutrient, if any, is limiting the growth of the *Cladophora.*

66. Title: *Sediment Oxygen Demand*

Principal Investigator: *N.A. Thomas,* Grosse Ile Laboratory, Office of Research and Monitoring, Environmental Protection Agency, Grosse Ile, Michigan 48138, Tel: (313) 226-6000.

Objective: Measuring oxygen demand of the sediments of Lake Ontario.

67. Title: *Main Lake Macrobenthos*

Principal Investigator: *N.A. Thomas*, Grosse Ile Laboratory, Office of Research and Monitoring, Environmental Protection Agency, Grosse Ile, Michigan 48138, Tel: (313) 226-6000.

Objective: Determining the biological quality of Lake Ontario as reflected by the abundance, composition, and distribution of the benthic community and relating the community structure to water chemistry measurements. *(273)*

68. Title: *Exploration of Halogenated and Related Hazardous Chemicals in Lake Ontario*

Principal Investigator: *G.D. Veith*, Water Chemistry Program, University of Wisconsin, Madison, Wisconsin 53706, Tel: (608) 262-2472.

Objectives: Analyzing fish, plankton, benthic fauna, sediments, and water collected in Lake Ontario for a wide range of toxic organic chemicals and determining the base level concentration of these materials. *(250)*

69. Title: *Basin Precipitation - Land and Lake*

Principal Investigators: *J.W. Wilson*, The Center for the Environment and Man, Inc., 275 Windsor Street, Hartford, Connecticut 06120, Tel: (203) 549-4400; and *D.M. Pollock*, Atmospheric Environment Service, Department of the Environment, 4905 Dufferin Street, Downsview, Ontario, Tel: (416) 635-4619.

Objective: Deriving measurements of precipitation over Lake Ontario and its basin through the integration of data from the Canadian and two U.S. weather radars and from all rain and show gages. *(107)*

Project Areas

One of the main accomplishments during the "reporting period" covered by this Bulletin (November 1971 - March 1972) has been the documentation of the tasks as summarized in the preceding section. There have also, however, been some changes in the broad project areas, as indicated in the text that follows.

Terrestrial Water Balance

Joint United States and Canadian plans have been completed for a number of activities related to the terms in the water balance equation. For inflow and outflow, this includes development of criteria for selection of an outflow measurement site, establishment of firm dates for calibration of the Leading Edge Flow Meter, simultaneous inflow-outflow measurements, and measurement of flow distribution around Wolfe Island. Planning is also complete for receipt of runoff data from both United States and Canadian sources for timely computation of the runoff term, for assessment of evaporation after receipt of all pertinent data, and for the installation of temporary water level gages at several stations and of Fischer-Porter water level gages on the offshore research towers near Olcott and Braddock Point, New York.

Lake Heat Balance

The objective of this project, which was outlined in IFYGL Bulletin No. 1, has been restated as follows:

> "Determine the three-dimensional structure of Lake Ontario and its variation with time; evaluate all energy terms and develop an energy balance; compute evaporation; determine lake heat storage and the relation between ice formation and decay and heat storage."

Products will include, in addition to those listed in Bulletin No. 1, ice forecasts, climatic influence, and environmental impact of thermal enrichment, and the approach will include measurement of the heat storage term, determination of the thermal structure and heat flux within the lake on a temporal basis, determination of the underwater light field, and computation of the energy budget.

Additional parameters to be measured are pressure and humidity as recorded by the ships, and pressure, humidity, and air temperature as recorded by buoys and towers.

New participants are F.H. Quinn, NOAA Lake Survey Center (ice measurements) and J.K. Grumblatt, NOAA Lake Survey Center (heat advection).

Lake Chemistry and Biology

To the objectives of this project has been added the development of predictive models as an aid in developing management policy. New participants are Leo J. Hetling, New York State Department of Environmental Conservation; Eugene F. Stoermer, University of Michigan; Nelson A. Thomas, EPA, Grosse Ile Laboratory; Andrew Robertson, IFYGL Project Office, NOAA; R. Burris, University of Wisconsin; D.E. Armstrong, University of Wisconsin; H.H. Kim, Wallops Island Station, NASA; Fabian C. Polcyn and C.T. Wezernak, University of Michigan; G. Fred Lee, University of Wisconsin; Samuel C. Mozley, University of Michigan; Gilman D. Vieth, University of Wisconsin; and Robert V. Thomann, Manhattan College.

John F. Carr, Great Lakes Fisheries Laboratory, Department of the Interior, has replaced James Reynolds as Project Director for the inventory of Lake Ontario fish stocks.

Water Movement

Scheduling of data acquisition for this project was completed at the IFYGL Washington Workshop in January 1972. Testing and instrumentation and planning of field operations are proceeding on schedule. Several of the participating scientists have reviewed data collected during the intercomparison of United States and Canadian buoys off Rochester in the fall of 1971. Although the quantity of data was small, results of the current meter intercomparisons are encouraging in that properly operating meters yielded very similar current structure. Successful measurements during the Field Year should provide satisfactory data for determining lake circulation.

Synthesis Program

To meet one of the central objectives of IFYGL - that of serving water resource management needs - the U.S. Project Office in mid-1971 developed the structure of a "Synthesis Program" that will provide a scientific basis for better management of water quality, water quantity, and environmentally sensitive operations in the Great Lakes area. The major projects, as outlined in <u>IFYGL Bulletin</u> No. 1, are primarily experimental projects with some modeling activities included. These projects are designed to increase our scientific knowledge concerning Lake Ontario in particular, and the Great Lakes in general. The "Synthesis Program" is designed to apply this knowledge to the solution of the management problem.

The way in which the individual IFYGL tasks relate to the broad project areas and, in turn, to the water resource management problem areas, is shown in table 1.

Five tasks pertinent to the Synthesis Program are identified in the IFYGL Technical Plan, Volume 1 - Scientific Program (sec. 8.2) as follows:

- Task 1 - Information requirements of Great Lakes water resource managers.
- Task 2 - Status of knowledge concerning Lake Ontario limnology.
- Task 3 - Preliminary "quick-look" data analysis.
- Task 4 - Data analysis.
- Task 5 - Modeling of natural distribution and variability of selected parameters.

A broad plan for carrying out these tasks has been developed by the U.S. Project Office, and efforts are underway to establish the nucleus of a multi-disciplinary team of scientists with capabilities in physical, chemical, and biological limnology, hydrology, water resources management, and numerical methods of analysis and prediction. Preliminary discussions have been held with representatives of the Great Lakes Basin Commission, the International Joint Commission, the Office of Sea Grant, and New York state agencies. Planning sessions have also been held with data management staffs, and the surface meteorological and oceanographic parameters for which "quick-look" analyses are desired have been identified. The purpose of such analyses is twofold: to check that particular data acquisition systems are operating properly and provide feedback information on their performance to the operations and maintenance staff at the U.S. Field Headquarters in Rochester; and to identify significant limnological events during the Field Year of which in-depth analyses may be desirable at a later date. Initial efforts have been concentrated on the ships *Researcher* and *Advance II* and on the network of buoys, towers, and automatic meteorological stations. Data from these platforms will be obtained at weekly intervals and graphic displays prepared with EDP equipment in the form of time series, time cross sections (Z,t), and horizontal (x,y) plots.

Table 1. Tasks, projects, and water resources management problem areas

		1. TERRESTRIAL WATER BALANCE	2. ATMOSPHERIC WATER BALANCE	3. EVAPORATION SYNTHESIS	4. LAKE HEAT BALANCE	5. LAKE CHEMISTRY AND BIOLOGY	6. WATER MOVEMENT	7. ATMOSPHERIC BOUNDARY LAYER	8. SIMULATION
SYNTHESIS PROGRAM	WATER QUALITY	X			X	X	X	X	X
	WATER QUANTITY	X	X	X			X	X	X
	OTHER ENVIRONMENTALLY SENSITIVE OPERATIONS		X		X		X	X	X
	PROJECTS								
TASKS	1. PHOSPHORUS SEDIMENTS					X			
	2. NET RADIATION				X	X	X		
	3. RFF/DC-6 BOUNDARY LAYER FLUXES			X				X	
	4. NITROGEN FIXATION					X			
	5. MENTOR BUOYS AND TOWERS							X	
	6. FISH POPULATIONS					X			
	7. MATERIALS BALANCE					X			
	8. RUNOFF	X				X			
	9. EVAPORATION - TERRESTRIAL WATER BALANCE	X		X					
	10. TERRESTRIAL WATER BALANCE ANALYSIS	X							
	11. LAND PRECIPITATION	X							
	12. TRANSPORT IN ROCHESTER EMBAYMENT					X			
	13. SOIL MOISTURE AND SNOW HYDROLOGY	X							
	14. MESOSCALE CIRCULATION							X	
	15. MESOSCALE SIMULATION							X	X
	16. LAKE LEVEL TRANSFER	X							
	17. NEAR-SHORE ICE				X		X		

Table 1. Tasks, projects, and water resources management problem areas (continued)

		1. TERRESTRIAL WATER BALANCE	2. ATMOSPHERIC WATER BALANCE	3. EVAPORATION SYNTHESIS	4. LAKE HEAT BALANCE	5. LAKE CHEMISTRY AND BIOLOGY	6. WATER MOVEMENT	7. ATMOSPHERIC BOUNDARY LAYER	8. SIMULATION
SYNTHESIS PROGRAM	WATER QUALITY	X			X	X	X	X	X
	WATER QUANTITY	X	X	X			X	X	X
	OTHER ENVIRONMENTALLY SENSITIVE OPERATIONS		X		X		X	X	X
PROJECTS									
TASKS	18. ADVECTION TERM - ENERGY BALANCE				X				
	19. GENESEE MATERIALS BALANCE					X			
	20. BOUNDARY LAYER FLUX SYNTHESIS			X				X	
	21. HAZARDOUS MATERIAL FLOW					X			
	22. EASTERN NEAR SHORE					X			
	23. CHLOROPHYLL - LIDAR MEASUREMENTS					X			
	24. TERRESTRIAL WATER BALANCE - INFLOW/OUTFLOW	X							
	25. FLOW MODEL	X							
	26. RADIATION, TEMPERATURE, & WATER VAPOR PROFILES							X	
	27. ALGAL NUTRIENT STUDIES					X			
	28. WAVE STUDIES						X		
	29. CLOUD CLIMATOLOGY		X		X				
	30. ZOOPLANKTON PRODUCTION					X			
	31. TERRESTRIAL WATER BALANCE - LAKE STORAGE	X							
	32. TERRESTRIAL WATER BALANCE - SOIL MOISTURE	X							

Table 1. Tasks, projects, and water resources management problem areas (continued)

		1. TERRESTRIAL WATER BALANCE	2. ATMOSPHERIC WATER BALANCE	3. EVAPORATION SYNTHESIS	4. LAKE HEAT BALANCE	5. LAKE CHEMISTRY AND BIOLOGY	6. WATER MOVEMENT	7. ATMOSPHERIC BOUNDARY LAYER	8. SIMULATION
SYNTHESIS PROGRAM	WATER QUALITY	X			X	X	X	X	X
	WATER QUANTITY	X	X	X			X	X	X
	OTHER ENVIRONMENTALLY SENSITIVE OPERATIONS		X		X		X	X	X
	PROJECTS								
TASKS	33. LAKE LEVELS MODEL	X							
	34. INTERNAL WAVES						X		
	35. *PONTOPOREIA AFFINIS* AND OTHER BENTHOS					X			
	36. PAN EVAPORATION			X					
	37. WATER MOVEMENTS						X		X
	38. TOWER PROGRAM							X	
	39. AIRBORNE SNOW RECONNAISSANCE	X							
	40. OPTICAL PROPERTIES				X				
	41. STORAGE TERM - ENERGY BALANCE				X				
	42. SENSIBLE AND LATENT HEAT FLUX				X				
	43. THERMAL CHARACTERISTICS AND ADVECTION						X		
	44. OSWEGO HARBOR STUDIES					X			
	45. REMOTE SENSING - STANDING WATER	X							
	46. REMOTE SENSING - *CLADOPHORA*					X			
	47. REMOTE SENSING - SUSPENDED SEDIMENTS						X		

Table 1. Tasks, projects, and water resources management problem areas (continued)

		1. TERRESTRIAL WATER BALANCE	2. ATMOSPHERIC WATER BALANCE	3. EVAPORATION SYNTHESIS	4. LAKE HEAT BALANCE	5. LAKE CHEMISTRY AND BIOLOGY	6. WATER MOVEMENT	7. ATMOSPHERIC BOUNDARY LAYER	8. SIMULATION
SYNTHESIS PROGRAM	WATER QUALITY	X			X	X	X	X	X
	WATER QUANTITY	X	X	X			X	X	X
	OTHER ENVIRONMENTALLY SENSITIVE OPERATIONS		X		X		X	X	X
	PROJECTS								
TASKS	48. ISLAND/LAND PRECIPITATION	X							
	49. LAKE CIRCULATION						X		X
	50. ATMOSPHERIC WATER BALANCE		X						
	51. EVAPORATION SYNTHESIS			X					
	52. TERRESTRIAL WATER BALANCE GROUND-WATER FLUX AND STORAGE	X							
	53. SPRING ALGAL BLOOMS					X			
	54. ICE STUDIES				X				
	55. LANGRANGIAN CURRENT OBSERVATIONS						X		
	56. LAKE CIRCULATION						X		
	57. PHYTOPLANKTON NUTRIENT BIOASSAYS					X			
	58. TERRESTRIAL WATER BALANCE - RUNOFF	X							
	59. COASTAL CHAINS						X		
	60. PHYTOPLANKTON					X			
	61. SATELLITES - CLOUD, ICE, AND SURFACE TEMPERATURES		X		X		X		

Table 1. Tasks, projects, and water resources management problem areas (continued)

		1. TERRESTRIAL WATER BALANCE	2. ATMOSPHERIC WATER BALANCE	3. EVAPORATION SYNTHESIS	4. LAKE HEAT BALANCE	5. LAKE CHEMISTRY AND BIOLOGY	6. WATER MOVEMENT	7. ATMOSPHERIC BOUNDARY LAYER	8. SIMULATION
SYNTHESIS PROGRAM	WATER QUALITY	X			X	X	X	X	X
	WATER QUANTITY	X	X	X			X	X	X
	OTHER ENVIRONMENTALLY SENSITIVE OPERATIONS		X		X		X	X	X
	PROJECTS								
TASKS	62. WESTERN NEAR-SHORE BIOLOGY AND CHEMISTRY					X			
	63. NCAR/DRI BUFFALO PROGRAM							X	
	64. EUTROPHICATION MODELING								X
	65. *CLADOPHORA* NUTRIENT BIOASSAY					X			
	66. SEDIMENT OXYGEN DEMAND					X			
	67. MAIN LAKE MACROBENTHOS					X			
	68. HAZARDOUS CHEMICALS					X			
	69. BASIN PRECIPITATION - LAND AND LAKE	X	X						

OPERATIONS AND DATA ACQUISITION SYSTEMS

U.S. Field Headquarters

The major U.S. observation systems are under the operational control of the U.S. Field Headquarters for IFYGL, located at 4800 Dewey Avenue, Rochester, N.Y. The Headquarters will begin activities on April 24 and during the field operations will be manned 24 hours a day, 5 days a week, and on weekends as necessary and whenever major units are deployed. Captain Kenneth MacDonald, NOAA, as Director, has the overall responsibility for the execution of the field operations, in support of which the following facilities have been established at the Field Headquarters:

- Communication system between the Field Headquarters and all major observation systems and participating elements, including the Canadian Operations Center at the Canada Centre for Inland Waters in Burlington, Ontario.

- Conference room accommodating 50 persons. Advance arrangements should be made with the Field Director.

- Instrument calibration facility. No major repair or facilities are available, and investigators should be prepared to operate on an individual basis.

- Electronic maintenance laboratory for the Physical Data System (Texas Instruments, Inc.) and DECCA Navigation System.

- Field Data Center to account for all data collected during the U.S. field operations and to control the flow and handling of raw data not destined for initial processing by individual investigators.

- Desks and working areas for four visiting scientists. Advance arrangements should be made with the Field Director.

- Weather information service, consisting of routine operational observations, forecasts, and warnings of potentially hazardous conditions. Units in the field will be responsible for obtaining such information from the Headquarters.

- Motor pool run on an "as available" basis, scheduled data courier service, and unscheduled general courier service. Vehicles cannot be driven by non-Government personnel.

- Duplicating service and secretarial support, when available.

- Mail service. Mailing address: Name of individual, Affiliation (name of ship, university, or agency), c/o IFYGL Field Headquarters, P.O. Box 4727, Rochester, New York 14612.

- Telephone service (area code 716). Rochester FTS Operator - 546-4900; Field Director, Operations, Maintenance Laboratory - 663-6050; Scientific staff, Data Center, Public Relations and Logistics - 663-3240.

Direct assistance to the Field Director is given by Kenneth Foulke, NOAA, Deputy Field Director, in the area of systems engineering for the observational systems, and by Terry E. Bryan, NOAA, in administration and operations, including fiscal disbursement, personnel allocation, and contract monitoring and review (see fig. 2). Additional administrative support related to logistics and facilities is provided by James Cumming and Howard Childress of NOAA. Lt. William Bradford, U.S. Coast Guard, is responsible for the installation, operation, and maintenance of the communication system at Headquarters. Aircraft, radar, and navigation operations are coordinated by Loran Weaver, NOAA. Coordinator of ship operations is Lt. Richard Moody, NOAA. Lt. J. Crowley has administrative responsibility for the buoys and land meteorological stations, and Chief Master Sgt. William Rummel, U.S. Air Force, will oversee the rawinsonde observations later in the Field Year.

Dan Hoydysh, NOAA, as Assistant IFYGL Data Manager, will supervise the Field Data Center operations. The role of the Field Data Center is discussed in greater detail in the section dealing with Data Management.

Ship Operations

Docking facilities with utilities are provided in Rochester by the Monroe County Port Authority for the *Researcher* and *Advance II* and by the New York Naval Militia for the smaller vessels. Data systems aboard the two large ships have been installed, and sensors are being calibrated at the National Oceanographic Instrumentation Center (NOIC), except for the electronic bathythermograph, which is being calibrated at the Canada Centre for Inland Waters (CCIW). The ships are expected to arrive at Rochester the third week in April and the first lake cruises are scheduled for the first week in May. The first lake cruises will be geared toward training of the crew and shakedown of the data systems. Scheduled overlap of the Canadian and United States cruises will assure continuity in the data gathered.

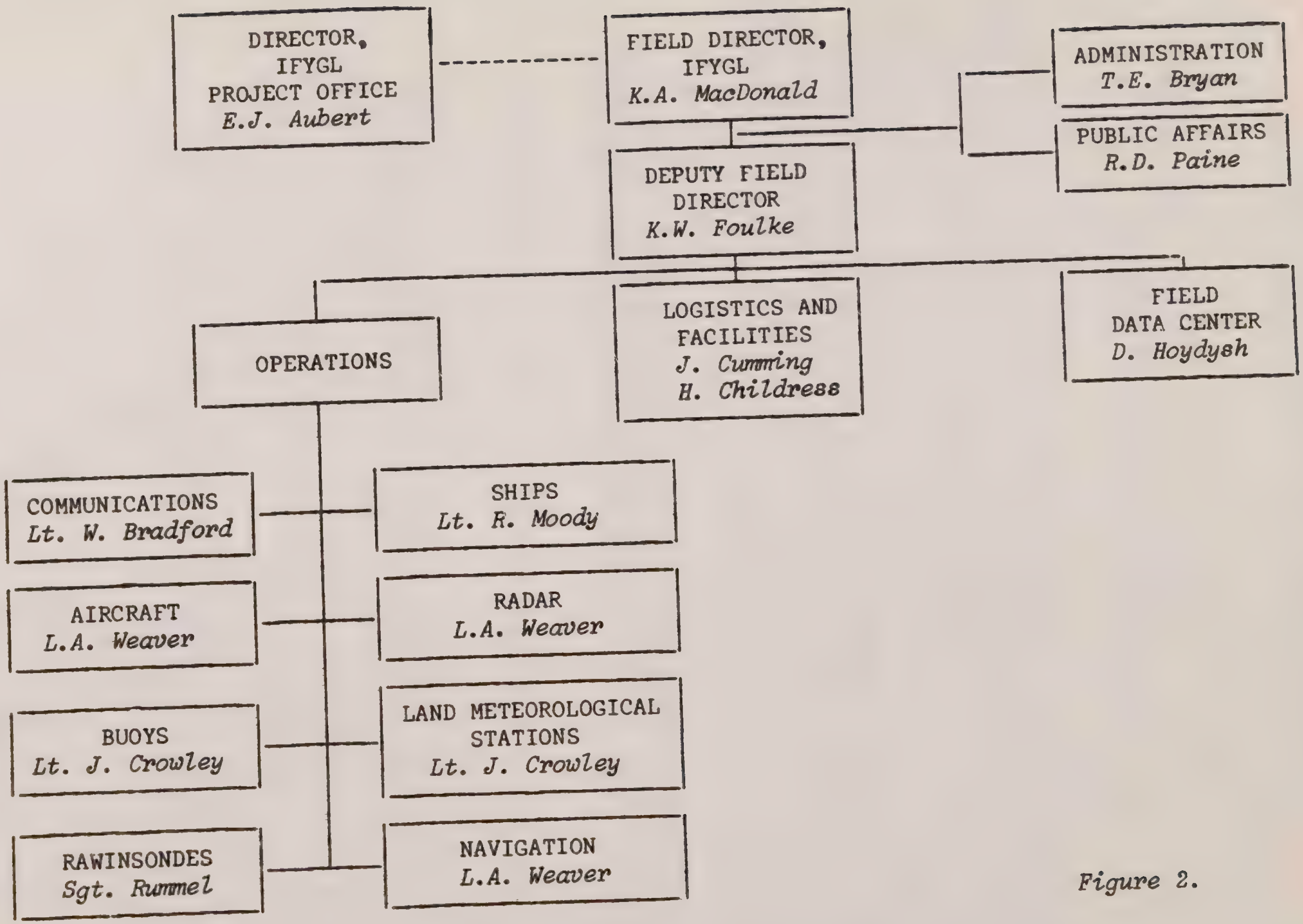
DIRECTOR, IFYGL PROJECT OFFICE
E.J. Aubert
FIELD DIRECTOR, IFYGL
K.A. MacDonald
ADMINISTRATION
T.E. Bryan
PUBLIC AFFAIRS
R.D. Paine
DEPUTY FIELD DIRECTOR
K.W. Foulke
OPERATIONS
LOGISTICS AND FACILITIES
J. Cumming
H. Childress
FIELD DATA CENTER
D. Hoydysh
COMMUNICATIONS
Lt. W. Bradford
SHIPS
Lt. R. Moody
AIRCRAFT
L.A. Weaver
RADAR
L.A. Weaver
BUOYS
Lt. J. Crowley
LAND METEOROLOGICAL STATIONS
Lt. J. Crowley
RAWINSONDES
Sgt. Rummel
NAVIGATION
L.A. Weaver

Figure 2.

Aircraft

U.S. aircraft participating in IFYGL are specially equipped for research and flights have been designed for study of specific meteorological and other physical properties in Lake Ontario and its Basin.

All aircraft operations will be conducted in accordance with United States and Canadian Federal Aviation Regulations as applicable. In the event an operator has obtained a waiver for any special reason, a copy of this will be provided to the Field Headquarters Director before the date of the mission.

Navigation procedures will include use of all available aids, including requests for radar and other traffic advisories from the appropriate ATC facility. Flying safety is paramount and will not be compromised.

Since most missions are dependent on weather, actual scheduled departure dates and times will be determined some 24 to 48 hours in advance of the flight. Periods for aircraft participation are given in table 2.

Radar Systems

The Oswego radar was fully operational 24 hours a day on March 31, 1972. Precipitation data are being recorded on IBM-compatible magnetic tape at 10-min intervals and on 16-mm film at 5-min intervals. The radar system is being calibrated every 12 hours. Radar precipitation data have been sent to The Center for the Environment and Man (CEM) and the magnetic tapes have been found to be compatible with CEM computers; the data and recording format appear to be satisfactory.

The Buffalo radar is operational with the National Weather Service D/RADEX system. Early hardware and software problems seem to have been solved, and data are being collected routinely on IBM-compatible magnetic tape.

Buoys, Towers, and Land Stations

Equipment for the buoy, tower, and land station network is being readied for installation. Sensors are being calibrated at the National Oceanographic Instrumentation Center, and deployment of the buoys is expected to begin the first week of May.

Table 2. Aircraft participation schedule

Period	Aircraft	Operator
April 30 - May 14, 1972	Buffalo	NCAR
	DC-6-39C	RFF, NOAA
	Aztec "C"	Cornell Aeronautical Laboratories
May or June 1972	C-46	University of Michigan
	C-47	University of Michigan
June 11 - 24, 1972	Queen Air	NCAR
	DC-6-39C	RFF, NOAA
	Aztec "C"	Cornell Aeronautical Laboratories
August 13 - 26, 1972	Buffalo	NCAR
August 16 - 31, 1972	Aztec "C"	Cornell Aeronautical Laboratories
Sept. 25 - Oct. 6, 1972	Aztec "C"	Cornell Aeronautical Laboratories
October 1 - 14, 1972	Buffalo	NCAR
	Queen Air	NCAR
	CV 990	Ames Research Center, NASA
October 8 - 21, 1972	Aztec "C"	Cornell Aeronautical Laboratories
November 5 - 8, 1972	Buffalo	NCAR
November 15 - 30, 1972	Aztec "C"	Cornell Aeronautical Laboratories
Nov. 21 - Dec. 7, 1972	DC-6-39C	RFF, NOAA
	DC-6-40C	RFF, NOAA
January - March 1973	Cessna	Lake Survey Center, NOAA
	RC-130 or 135	U.S. Air Force
	Twin Beach Bonanza	EG & G, Inc.

Rawinsondes

A meeting was held at Beukers Laboratories, Inc., April 11 - 12, 1972, for discussion of details concerning the LOCATE training program to be conducted at Beukers from May 15 through 24. The class of seven to receive this training includes the following:

United States	Canada
T/Sgt. Kenneth A. Brown, USAF	Miro Kontiuk
S/Sgt. James H. Adair, USAF	A.R. McFadden
S/Sgt. Frederick McSpadden, USAF	G.A. Toole
S/Sgt. Jerry Yeager, USAF	

Beukers will install two sets of leased Canadian equipment between September 1 and 6, 1972, at Presqu'ile and Stoney Creek. A purchased set will be installed at Scarborough, Ontario.

The three U.S. rawinsonde stations at Lakeside Beach, Sodus Point, and Stoney Point will be installed by Beukers between Septempber 6 and 15. This schedule will affect the rawinsonde release plan given in Volume 3 of the IFYGL Technical Plan, since two test runs per day had been originally scheduled for September 14 - 16.

EPA Water Chemistry Laboratory

The Rochester, N.Y., office of EPA has recently moved into the new chemistry and biology building at the University of Rochester, Hutchison Hall. This structure was especially designed as a chemistry building.

The EPA laboratory will be running chemical analyses on the major portion of water samples for the U.S. program. The laboratory is equipped with a Technicon CSM-6, Technicon AA II, Perkin-Elmer AA Model 403, and a Beckman Total Organic Carbon Analyzer. These will all be attached to a Fluidyne analog-to-digital interface, a Wang 720 C and a Wang printer-plotter. This will allow for a high volume of samples to be run per day, and since it is an automated system accuracy should be enhanced.

Ammonia, nitrate-nitrite, soluble orthophosphate, fluoride, silica, sulfate, Kjeldahl nitrogen, total phosphorus and soluble phosphorus will be run on the Technicons. Most metals will be run on the Perkin-Elmer AA, with the exception of mercury, which will be done on a Coleman Mercury Meter Model MAS-50.

Mr. Lorne David Drury will begin his duties as IFYGL Data Manager on April 1, 1972, and Mr. Dan Hoydysh on May 1 as Assistant Data Manager. Initially, both will spend several weeks at the Field Data Center at the U.S. Field Headquarters in Rochester, with Mr. Hoydysh subsequently being responsible for supervision of the Data Center. Data under the Center's control include those obtained from the following acquisition systems:

> The ships *Researcher* and *Advance II* (all data collected during the scheduled cruises, data obtained for special purposes by individual investigators aboard ship to remain in the possession of these scientists); Texas Instruments buoy, tower, and land and island station system (data consisting of backup magnetic tapes and maintenance and calibration information only); Oswego and Buffalo radar installations; Rochester precipitation network; rawinsonde stations, both United States and Canadian.

The 6th Mobile Squadron of the U.S. Air Force Air Weather Service will provide data handlers and inter-government couriers. Water samples from the two ships will be transported and delivered to the EPA Water Chemistry Laboratory in Rochester; magnetic tapes and support information from the automatic data systems aboard these ships will be delivered to CCIW, Burlington, Ontario

Data collected from the above systems will be inventoried and checked at the Data Center, which will also prepare data shipments to users. Files will be maintained of data receipts and shipments, calibration and intercomparison data, summaries of participants' field activities, operations reports, event logs, IFYGL sample identification logs, and printed output for the Texas Instruments system. Arrangements are pending for providing, through local computer facilities, copying service for radar and rawinsonde magnetic tapes. Photographic radar films will be processed by local contractors. The Data Center will also maintain data acquisition system and processing supplies.

Of particular importance is the Field Data Center's responsibility of updating the IFYGL Data Catalogue based on responses from participants in accordance with procedures outlined in the IFYGL Technical Plan, Volume 4 - Data Management Plan. The Center will provide all update information to the U.S. Data Center in Washington D.C. for monthly production and distribution of the IFYGL Data Catalogue to U.S. participants.

Participants are also requested to inform the Assistant Data Manager at the Field Data Center in Rochester of any changes in their tasks that require changes in the IFYGL Technical Plan, in order that current awareness be maintained among all participants concerning modifications of the Plan.

CHEMICAL OBSERVATIONS, CALIBRATION, AND STANDARDIZATION

On March 9 and 10, 1972, a joint U.S. - Canadian Chemical Standards Meeting was held in Rochester, N.Y., to work out uniform chemical analytical procedures.

Major topics of discussion were methods of sample collection and preservation, and quality control, with a view toward standardizing methods to be used by United States and Canadian investigators.

Although the Canadian and U.S. water chemistry programs are different in scope, they are complementary. The U.S. study is primarily a survey, while Canadian emphasis will be on the thermocline. Analytical methods are similar, and some sample swapping and running of spiked samples will be done to make sure the results are inter-comparable.

For the U.S. water collection program, it was decided that pretreated bottles were to be used in obtaining three samples: one unpreserved and unfiltered, one filtered and frozen, and one unfiltered sample spiked with 5 ml of concentrated HNO_3/liter for open lake water and 5 ml concentrated HNO_3 plus 5 ml 1:1 HCl/liter for stream and near-shore samples. All acids must be pure and blanks held for later analysis.

Robert Booth of the EPA NERC Analytical Quality Control Laboratory in Cincinnati, Ohio, has supplied a great deal of information on the necessary controls to assure precision, and these recommendations will be put into effect in the Rochester laboratory. They include running spiked samples and replicates every 15 samples. In addition, a reference sample, supplied by the Cincinnati laboratory, will be run once a week.

Other discussions between participants were held and, where feasible, programs are being extended to accommodate the needs of each individual program. These problems are being worked out directly between the individuals concerned.

FROM THE DESK OF THE U.S. COORDINATOR

A Look at IFYGL History

Realizing that a discussion of the "birth" and early history of IFYGL should more appropriately have had a place in IFYGL Bulletin No. 1, I believe that a brief looking back might still be of interest to those whose affiliation with the IFYGL program postdates the conception of the program and who have little or no information regarding the beginnings of IFYGL and its history up to this time. For such information I have drawn on an excellent paper by Dr. W.C. Walton, "Hydrological Aspects of the International Hydrological Decade (IHD)," that appeared in Ground Water, Vol. 4, No. 4, October 1966, as well as on material made available by Dr. A.P. Pinsak, Mr. S.J. Bolsenga, and Drs. I.C. Brown and L.A. Heindl, Executive Secretaries of the Canadian and U.S. National Committees for the IHD, respectively.

The real beginning of IFYGL may be taken to the action of the Executive Board of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) when in 1961 it adopted a resolution drawing attention to the importance of hydrology in world affairs. There was considered to be a need for:

- A preparatory meeting of experts to discuss this topic.
- A subsequent intergovernmental conference, for further deliberations.
- Coordination and consultation with appropriate international scientific organizations then in existence.

UNESCO convened the preparatory meeting in Paris in 1963, when 76 scientists from 8 organizations met to discuss the desirability and potential scope of an international program in hydrology. The report of this meeting was sent to the then 112 member states of UNESCO and to other international agencies and scientific organizations for review and comment.

In 1964, UNESCO convened an intergovernmental meeting in Paris, attended by about 150 representatives from 38 countries, 5 U.N. agencies, and 11 scientific organizations. This meeting endorsed the creation of a Coordinating Council for the International Hydrological Decade (IHD). UNESCO set the opening date for the IHD as January 1965, and member states that had not already done so were urged to form National Committees for the IHD. Today, 106 nations are participating in the IHD.

By mid-1964 the U.S. National Academy of Sciences - National Research Council established the U.S. National Committee for the IHD at the request of the Department of State, and the first meeting of this group was held in November 1964.

In May 1965, the Coordinating Council for the IHD prepared an overall program statement outlining 69 IHD activities divided into the five following broad categories: basic data; inventories; research and special data; education and training; and exchange of information.

Implicit in this program was the encouragement of regional international projects involving two or more countries interested in working together on problems or areas of mutual interest.

During the same period that UNESCO's IHD program was being developed, the Canadian National Committee for IHD received a proposal from Dr. D.V. Anderson, University of Toronto, which embodied the substance of IFYGL. The proposal spoke directly to the need for United States - Canadian cooperation and the Canadian NC/IHD wrote the U.S. NC/IHD on 17 September 1965 and suggested further discussions on the Anderson proposal. In response, the U.S. NC/IHD suggested a meeting in early November 1965. This meeting was held in Urbana, Ill., on November 11 and 12 and was attended by W.C. Ackermann, Vice Chairman of the U.S. NC/IHD and Chief of the Illinois Water Survey; W.H. Durum, U.S. Geological Survey; M.A. Kohler, U.S. Weather Bureau; J.P. Bruce, then with the Division of Hydrometeorology of the Canada Department of Transport; and J.F. Fulton, Assistant Secretary to the Canadian National Committee for the IHD. The meeting recommended the establishment of a Joint Steering Committee composed of Canadian and United States representatives whose initial functions were:

- To select one of the Great Lakes for an intensive study.
- To plan the study effort.
- To keep the Canadian and U.S. NC/IHD's informed of progress.

The meeting also outlined the need for four of the five basic component programs of IFYGL.

In June 1966, the U.S. NC/IHD held its third meeting and appointed a number of Work Groups, covering 10 areas of effort, one of which was IFYGL. The members of that Work Group comprised the U.S. half of the Joint Steering Committee for IFYGL. The original members were W.J. Drescher, D.C. Chandler, D.L. Harris, and A.P. Pinsak. This action placed IFYGL under the IHD umbrella. Unlike many other IHD projects that are either multinational or purely national, IFYGL is binational.

In July 1966, the two National Committees agreed to establish the Joint Steering Committee (JSC), which held its first meeting in Toronto on August 9, 1966. Shortly thereafter, Lake Ontario was selected for study, and a tentative schedule of preliminary and intensive activities was proposed for the period 1967-1972.

By the time of its 10th meeting, in Detroit, October 22, 1968, the JSC had already laid a detailed groundwork for the Field Year, but budgetary considerations postponed the start of the major effort until 1971. This schedule, with minor slippage into 1972, has been maintained despite a host of problems that included internal governmental reorganizations on both sides of the border.

Lead agency responsibility for the U.S. part of the Field Year was assigned in 1968 to the U.S. Army Corps of Engineers, which in turn assigned operational responsibility to the Lake Survey Center in Detroit. On October 3, 1970, the National Oceanic and Atmospheric Administration (NOAA) was formed. Among the governmental components transferred to NOAA was the Lake Survey Center, and the lead agency responsibility for the IFYGL was also shifted to NOAA. This caused a concomitant realignment of the management techniques for IFYGL on the U.S. side, consistent with the modus operandi employed by NOAA and by the Environmental Protection Agency (EPA), which has responsibility for the biological and chemical projects of the U.S. program. The Joint Steering Committee has continued to provide policy control of IFYGL under the IHD organization, and thus to provide advice and guidance to NOAA in the execution of the U.S. part of the programs.

However, an operational arm has had to be established to expedite and coordinate the management of activities on the U.S. side with those in Canada. Accordingly, a Joint Management Team (JMT) was organized in October 1971. The Canadian side of the JSC has always been composed of men representing the operational agencies, so the Canadian section of the JMT is identical to Canadian representation on the JSC. On the U.S. side, however, JMT membership is essentially restricted to those U.S. agencies with prime responsibility for expending U.S. funds - NOAA and EPA.

This evolution into two groups has worked effectively. The JSC makes policy, provides guidance and leadership, and reports back to the two National Committees, while the JMT supervises execution of the projects, provides the management resources, and reports progress to the JSC. Each organization keeps the other cognizant of progress and plans, a process facilitated by overlapping memberships.

Thus IFYGL, which now has a definite series of specific projects operating on fixed time schedules, has a history well back into 1961. In all probability preliminary analysis of the data collected during the period of intensive field work - the Field Year itself - will not be finally completed until 1975.

While IFYGL looms large in the minds of participants, it is only one of a number of programs established under the International Hydrological Decade under the sponsorship of UNESCO to study the hydrological problems on a world-wide basis and to encourage all countries, individually and collectively, to improve their abilities to cope with their water problems.

Announcements

A new telephone directory of U.S. participating offices and scientists is in preparation. The Canadian Coordinator will be furnished with 100 copies for his distribution.

U.S. Government employees can be exempted from paying state hotel taxes in New York if they fill out the exemption certificate shown on the next page. Use of a Xerox copy of this certificate is acceptable.

ST-129 (10/70)

STATE OF NEW YORK

Operators of hotels, etc., should not accept this certificate unless the officer or employee presenting it shows satisfactory credentials.

TO BE RETAINED BY OPERATORS OF HOTELS, MOTELS, AND SIMILAR ACCOMMODATIONS AS EVIDENCE OF EXEMPT OCCUPANCY

EXEMPTION CERTIFICATE
TAX ON OCCUPANCY OF HOTEL ROOMS

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NAME OF HOTEL, APARTMENT HOTEL, OR LODGING HOUSE

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This is to certify that I, the undersigned, am a representative of the United States Governmental department, agency or instrumentality indicated below; that the charges for the occupancy at the above establishment on the dates set forth below have been or will be paid for by such governmental unit; and that such charges are incurred in the performance of my official duties as a representative or employee of such governmental unit.

DATES OF OCCUPANCY ______________________ ______________________

(SIGNATURE)

GOVERNMENTAL UNIT ______________________ ______________________

(TITLE)

NOTE - A SEPARATE EXEMPTION CERTIFICATE IS REQUIRED FOR EACH OCCUPANCY AND FOR EACH REPRESENTATIVE OR EMPLOYEE